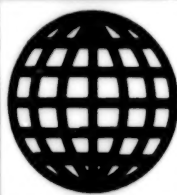


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ADVANCED MATERIALS

Germany: New Radial-Flow Catalyzer to Improve Stainless Steel Production

93WS0579A Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 24 Jun 93 p 8

[Unsigned: "Catalyzer With Radial Flow"]

[Text] Frankfurt. Considerable quantities of noble metal could be saved in the construction of catalyzers if a new manufacturing method based on the radial flow principle was to be introduced industrially on a broader basis in the opinion of the enterprise Bosal GmbH (Metallstr. 5, 41751 Viersen). The chairman of the board of the enterprise, Karel Bos, estimates the potential savings at about two billion DM in the automotive industry alone.

The new radial flow converter at the enterprise required only half the quantity of noble metal of a conventional catalyzer. What it amounts to is that, instead of the conventional ceramic supporting monoliths, now rust-free, high-quality stainless steel is used, which is advantageous with respect to manufacturing costs.

The radial flow method optimizes the flow of gas through the catalyzer in which the flow velocity is slowed and the gas is radially diverted before it arrives in the catalyzer. This will be related to a considerably increased density of cells in the substrate, according to statements from the enterprise, as a result of which a considerably better contact is produced between the waste gas and the noble metal. This leads to the best possible transformation of harmful gases into safe gases.

The radial flow converter developed by Bosal in cooperation with the Finnish enterprise Kemira Specialty Products could, after comprehensive testings have been successfully concluded as early as 1995, be successfully applied in the automotive industry.

EC Support for Diamond Film Development

93WS0710B Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 6 Sep 93 p 10

[Article by "oel": "EC Support for Diamond Cutting Wire. The Conventional Blasting Process Will Become Largely Unnecessary"]

[Text] Frankfurt—The European Commission is specifically supporting within the Cooperative Research Action for Technology (CRAFT) program small and medium-sized enterprises having a certain innovation potential but that do not themselves have the financial means to finance independent research.

A somewhat remarkable project among the numerous CRAFT activities may not be typical but could shed light on the commission's future decisions and selection criteria: A new type of diamond-coated wire is to be

developed and made ready for the market that cuts stone—from sandstone to granite and marble—easily, quickly and with less harm to the environment and less danger to quarry workers than today's stone saws do. The saw wire is also to be so usable that it will make the blasting process largely unnecessary.

The Commission of the European Communities (General Headquarters XII, Rue de la Loi 200, B-1049 Brussels, Belgium) calculates that 70 percent of the 5,000 active stone establishments in the entire world lie within the borders of the European Community, and, furthermore, that 90 percent of the companies that manufacture the machines and equipment for stone quarrying and the further processing of stone are also domiciled in Europe. Yet in addition, a stated objective is that the new type of diamond saw wire be so designed that it is to improve by 10 percent the productivity of stone establishments. Besides, synthetic diamonds are to be used instead of industrial diamonds.

The project, which is being carried out by a group of Spanish and Portuguese companies, is in the opinion of experts so remarkable because diamond-coated cutting wire rope of this type has been available already for years and is supplied even in endless loops more than 30 meters long for various special areas of application.

It is true that the circle of suppliers in the world is small, but their service also includes, among other things, refinishing used cutting wires and recoating them with diamond, which also can be recovered in part from the water used as a cutting fluid. It is certainly conceivable that new types of polymers can be found for bonding the diamond that will make it necessary to restore the cutting wire less often.

Germany: Strong in Materials Development, Weak in Practical Applications

93WS0707A Berlin INGENIEUR DIGEST in German Aug 93 pp 16-17

[Article by Guenther Ludvik]

[Text] Islands of Competence

The Germans are strong in important areas of materials development, according to a study made by the Arthur D. Little consulting firm. Weaknesses are found in quick practical application of the results.

German materials development has something to show off. However, as the Federal Ministry of Research and Technology (BMFT) reports, researchers too often fight their own battles. Individualization and isolation of research activities, a phenomenon already known in other research areas, must now be combated. "Reassertion of the national competence in the area of material and processing technologies requires that all industrial and academic research become more strongly

interlinked. The existing 'islands of competence' must be integrated into comprehensive networks" insists the BMFT.

The premise is correct, confirms the Wiesbaden business consultant Arthur D. Little. Analysts are assessing the accomplishments of the materials research program started by the BMFT in 1985. Under this program, indeed, industry and commerce have initiated joint projects costing altogether almost two billion marks.

The research consultants extracted essential data from patent examinations, from analyses of trade balances in technology-intensive goods, from economic indicators, and also from interviews with 120 German and 40 foreign experts. At the same time more than 100 German academic and industrial research specialists had filled out relevant questionnaires. The conclusion: "The singular strengths are not being sufficiently built upon and the results of research and development at the individual value added levels are not consistently tied together."

This judgment can crucially influence Germany's future competitive position. Innovations and success on the world market are based on new and advance materials. This is why all leading industrial countries rate materials research as a key technology and support it accordingly. They invest considerable resources in it so as to secure technological and marketing advantages.

A comparative evaluation of support programs worldwide does, however, reveal unequivocally that money alone does not guarantee success. Not the amount of aid is of decisive importance but rather how the government funding of research and development is coordinated with private investments in innovation. By way of comparison, modest national support programs could sometimes be much more effective.

Figure 1. Absolute Magnitude of Research and Development Expenditures: Much Money Alone No Guarantor of Success

Key: 1. Million \$US 2. U.S.A. 3. Japan 4. Germany 5. France 6. Great Britain 7. Source: Organization for Economic Cooperation and Development (1992) and BMFT data

Take Japan, for example. Nowhere else is the commitment to expanding research and development so strong. There the greatest successes are always achieved when government support is harmonized with the research and development strategies of the largest enterprises aimed at ensuring realization of economic benefits. Conversely: most failures have occurred when government institutions wanted to push through projects with limited funding and contrary to the interest of expert enterprises.

This diagnosis could lead to a cure of ailing German programs as well. Much needed is setting priorities. At this time there are about 40,000 metallic and about as many nonmetallic structural materials on the market.

Though these numbers are already hardly comprehensible, they will increase further within the coming years. Obviously, technological quantum leaps are often due to significantly improved materials or development of new ones.

Novel materials alone are quite marketable. The market volume worldwide is gigantic (Figures 1). The market for semifinished products and component parts made from high-performance materials will more than double to an about 150 billion marks worth. The future average growth in high-performance materials is anticipated to be: 11% in metals and alloys, 9% in ceramics and polymers, 5% in adhesives.

Figure 2. Total Sales of High-Performance Materials: Doubling by Year 2000.

Key: 1. High-performance polymers 2. High-performance ceramics 3. High-performance metals 4. High-performance adhesives 5. Sales of basic materials in billion DM, 8 billion DM in 1990 6. Sales of semifinished products and component parts, 65 billion DM in 1990

As reported by Arthur D. Little analysts, the BMFT materials research program is already accomplishing a great deal toward ensuring that the Germans remain in the race. The most important conclusions of their study are: 1. Parity with developments in the leading countries, U.S.A. and Japan, has been maintained. 2. The program has substantially contributed to trend setting developments in materials research. 3. Essential necessary capabilities in materials science have been brought together for the program. 4. The constraints of the program are well defined and match the particular importance of the subject matter. 5. The concept of joint research has been validated. 6. Productive research and development establishments enjoying worldwide recognition have been organized in both academia and industry. 7. With only a few exceptions, the targeted sets of goals are being reached.

The study points to the over 340 patents, 1,800 publications, and 2,500 lectures mentioned in the annual program reports over the 1985-1991 period as indicators of scientific and technical achievements. German enterprises which have intensely participated in the program are now, unlike in 1985, among the most patent-active ones worldwide.

Independent project partnerships have been promoted by the BMFT, which over the period from the beginning of the program till February 1992 has made them a total of 1111 offers. The total market volume of the projects is 1,620 million marks at an investment of 894 million marks, 254 million and 640 million of which having been made available for academic and industrial research respectively.

The results vary (Figure ?). Germany's position in high-performance polymers is strong. In adhesives and functional ceramics, however, its position ranges weak to

average. Here parity with the leaders in technology across the ocean, U.S.A. and Japan, is threatened.

Figure 3. Technology: Where the Germans are Ahead on the International Scale

Key: 1. Relative position (Germany's) in technology 2. Technological activity 3. Strong 4. Average 5. Weak 6. Slight 7. Medium 8. High 9. Functional polymers 10. Structural polymer 11. Structural ceramics 12. Adhesives 13. Functional metals 14. Glasses 15. Structural metals 16. Functional ceramics 17. The size of circles indicates worldwide market volume of semifinished products or component parts made from high-performance materials, estimated in billions of DM for the year 1990 on. 18. Investment sectors 19. Optional sectors 20. Divestment sectors

The situation in other classes of materials ranges from favorable to average. Important processes are being mastered, parity is being maintained, and even a leading position has been reached in a few classes of materials.

The consequences of this evaluation have been formulated by the BMFT in terms of "strategic goals": 1. Ensuring technological competence of Germany as an essential success index in its ability to compete. 2. Attainment of technologically leading positions in strategically chosen significant application areas for high-performance materials. 3. Consideration of long-term ecological aspects. 4. Accelerating diffusion of high-performance materials as well as component parts and systems made from them into the appropriate market sectors.

It is precisely regarding quick conversion of research output into practical use that the study made by Arthur D. Little urges a faster pace, inasmuch as many developments are not yet being utilized and bringing them to the market takes a long time. Therefore, the BMFT will strengthen its support of research partnerships along the entire value-added chain and according to the system approach to problem solutions. It is to be hoped that the "Mat-Res" (Materials Research) generation which has worked on projects in numerous enterprises, having been sensitized to the concerns of material research and educated, will then sooner contribute to the "echo effect".

CMC Parts Development

93WS0690A Nagoya PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 4-9

[Article by Pierre Lamicq, European Propellant Co., Saint-Medard-en-Jalles, France]

[Abstract] Carbon matrix composites produced by chemical vapor infiltration inside preforms that are made

using continuous carbon or ceramic fibers exhibit specific damage and rupture features. They perform as non-brittle, damageable material, with nearly no stress concentration sensitivity.

Engineers have taken advantage of this in developing parts. For one-time-only uses involving high loads, they have modeled the non-linear stress/strain relationship and measured modifications in the stiffness matrix. Tension/shear interaction is more difficult to study.

The resistance of CMC parts to cyclic loads and fatigue is excellent in inert atmospheres. Oxidation or corrosion at high temperatures is much more harmful. Predicting the life of a material requires accurate knowledge of environmental conditions, plus a good set of representative tests. CMC parts have been developed and successfully tested for a range of high-temperature, heavy-duty applications, including an aerodynamic grid for a small turbine engine, nozzle flaps, a satellite rocket motor, an exit cone, large Hermes-shuttle parts, and a ramjet motor chamber.

Effective Use of Polymer Blends in Polymer Matrix Composites

93WS0690B Nagoya PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 17-22

[Article by Ivana Partridge, School of Industrial and Manufacturing Science, Cranfield Institute of Technology, Cranfield, Bedford, U.K.]

[Abstract] The paper concerns the transfer of toughness from blended thermoset/thermoplastic matrix resins to their corresponding continuous glass or carbon fiber reinforced composites. Geometrical restriction of the crack tip "process zone" is shown to be responsible for the inefficient Mode I fracture resistance transfer from the tougher modified thermosets to their unidirectional laminates. Mode II fracture resistance of non-interleaved composites and of composites containing a central layer of the self-same matrix resin is related to fracture micromechanisms and fatigue failure. Examples are given to show that careful control of the spatial distribution of fibers and resin can be exploited to achieve higher toughness enhancement in composites than is available by resin modification alone.

Progress on Non-destructive Testing, Observation Methods for Composite Materials

93WS0690C Nagoya PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 56-60

[Article by Claude Bathias, Christophe Le Ninven, Dongliu Wu, Conservatoire National des Arts et Metiers, Paris, France]

[Abstract] X-ray tomography is replacing ultrasound in materials research because of its superior spatial resolution and ability to measure attenuation. The authors' laboratory set up a CGR ND 8000 scanner, which they equipped with a 50-KN monotonic compression/tension machine for observation of materials under mechanical loading. Their objectives were to observe internal geometrical defects; display variations in homogeneity; reveal differences in texture, chemical structure, and concentration; observe the evolution of mechanical, physical, and chemical damage; and pinpoint and quantitatively calibrate phenomena. The authors conclude that X-ray tomography is a powerful tool for non-destructive testing of polymer, ceramic, and metal-matrix composite materials. It is also a good way to insure quality and processing control—to monitor, for instance, the volume fraction of fibers or particles. Finally, the authors consider X-ray tomography a possible tool for identifying chemical composition or locating different chemical phases inside materials.

Long-Term Damage of Glass-Fiber-Composite Pipes Under Internal Pressure

93WS0690D Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in French 01 Jun 93 p 70-75*

[Article by J. Pabiot, P. Krawczak, C. Monnier, Polymers and Composites Department, Ecole des Mines de Douai, Douai, France]

[Abstract] Glass-fiber, filament-wound composite pipes are increasingly used to transport liquids under pressure. To improve our understanding of the mechanisms involved in aging, this paper presents a comparative analysis of the damage suffered by pipes under different internal pressure laws, as a function of interface and matrix deformation capability, which are the most important parameters in composite cohesion. Increasing pressure was first applied to the composite pipes internally, after which the resulting multidirectional strains and acoustic spectrum were measured. An analysis of the results shows initial damage, followed by constant stiffness and later weeping. A damage model showing the location of initial cracking and crack growth is proposed, followed by an analysis of the influence of these short-term cracking mechanisms on the long-term behavior of pipes under constant or repeated pressure.

The mechanisms involved in initiating damage were found to depend essentially on interface quality. In contrast, weeping or bursting mechanisms depended on matrix deformation capability and gel-coat structure. The timing, initiation, growth, and levels of fracture depend greatly on the pressure law, with no particular correlation between short and long term. Tests are therefore needed to determine the optimal design of composite pipes under permanent pressure.

Current European Progress in the Recycling of Ground Scrap from Reinforced Plastics Into Newer Products

93WS0690E Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 116-120*

[Article by Dr. G.F.G. Mavel, E X M Co., Antony, France]

[Abstract] Although the automobile industry's reuse/recycling of reinforced THERMOSETS, i.e. glass-fiber-polyester systems, is well documented, much basic R&D is being done across Europe as well. This paper presents the development of practical solutions for recycling SMC and BMC scrap in the building and electrical trades, including solutions for less conventional resin systems such as phenolics or polyurethanes.

Though a less popular topic of study, significant progress has recently been made on both long and short-fiber reinforced THERMOPLASTICS. Suppliers of fiber-containing compounds have found it crucial to help their customers dispose of production and post-consumption scrap, and to revamp those materials for use in competitive products.

Alpha Aluminum Trioxide Hexagonal Platelets, Their Preforms, Composites

93WS0690F Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 129-135*

[Article by Jacques Mace, Elf Atochem - France, Paris, France]

[Abstract] For the last several years, Elf Atochem has been offering new alumina platelets under the registered trademark PYROFINE PLAT. The company can supply different grades of the monocristalline, hexagonal, alpha-alumina platelets, which are grouped by mean platelet size. The platelets are used to make porous preforms, which are free of large aggregates and silica impurities (one percent). Several metallurgists tested the Elf Atochem preforms in metal-matrix composites. Mechanical performances were encouraging. The squeeze-casting technique under infiltration pressure of 50-75 MPa was used to prepare most of the reinforced specimens. The method produced isotropic and very regular materials, without any porousness or disturbance of the platelets' random orientation. The MMCs' mechanical properties were measured on 6061 alloy matrix composites and compared to composites obtained using other reinforcing media. When the elastic modulus of various MMCs was compared to the Pyrofine preform, only SiC whiskers outperformed it with a 20 percent volume fraction. The Pyrofine preform also demonstrated good tensile strength. In pure aluminum matrices, the smallest platelets proved to be the best. Extrusion experiments to align the platelets in the matrix showed good orientation in the rolling direction, without much destruction of

particles. Both squeeze-casting and power metallurgy have been used successfully to manufacture MMCs with Elf Atochem's platelets, which means platelet powders can be used as well. Other kinds of matrices can be reinforced with the materials, and programs involving organic and ceramic matrices are underway.

Investigation of Melt-Preform Interactions in Aluminum Alloy-Based Metal Matrix Composites Incorporating Alumina Fibers

93WS0690G Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 148-156*

[Article by S. Fox, H.M. Flower, and D.R.F. West, Department of Materials, Imperial College, London, England]

[Abstract] An investigation has been made of the chemical and physical interactions between the reinforcement medium, binder material, and aluminium alloy matrix in a series of metal matrix composites produced by pressurized liquid metal infiltration of fibrous preforms. The influence of fiber additions on matrix morphology has been investigated by light microscopy of polished sections. Detailed microstructural and microchemical analysis has been carried out on thin sections produced by a specialized specimen preparation technique involving mechanical dimpling and ion beam thinning. This has enabled the identification of matrix constituent phases and chemical composition, and the characterization of fiber and binder microstructure and microchemistry using X-ray energy dispersive spectroscopy (EDS) and electron diffraction techniques in the TEM. The relationship between the fiber/binder microstructure and the degree of interaction with reactive alloying additions is discussed.

Elastic Limit in Discontinuous Reinforced Metal Matrix Composites

93WS0690H Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 148-156*

[Article by R. Fougères, E. Maire, G. Lormand, P.-F. Gobin, Physical Metallurgy and Materials Physics Research Group, INSA, Villeurbanne, France]

[Abstract] Thermal treatments applied to metal matrix composites induce thermal stresses that give rise to different proportional limits during compression and tension mechanical tests. A look at the maximum TRESCA shear stress along the particle-matrix interface gives us a clear understanding of this behavior. Different tension and compression work-hardening rates for the very small amount of microplastic strain causes the curves to intersect. The difference is attributed to an increase in interstitial dislocation loops—which are emitted to relax the thermal stress field—during mechanical compression stress, and to a drop in their number during tension stress. The metal matrix becomes

wholly deformed plastically beyond a certain yield stress, which is modeled using a "three-phase" equivalent material composed of particles, matrix that is affected by the thermally-emitted dislocations around the particles, and unaffected matrix. A mixture law and a model for determining the extension and properties of the affected matrix are used to realistically describe the effect of particle size on yield stress.

Velocity Accommodation in Composite/Metal Contacts

93WS0690I Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 163-168*

[Article by C. Turki, A. Chateauminois, M. Daoud, M. Salvia, and L. Vincent, Ecole Centrale de Lyon, Materials - Physical Mechanics Dept., Ecully, France]

[Abstract] Fretting tests were employed to investigate the tribological behavior of unidirectional glass/epoxy composites with steel counterfaces. Using the interface tribology concept, we discuss the velocity accommodation mechanisms for different fiber orientations versus the contact surface of the glass-fiber-reinforced epoxy material. Results were analyzed in two steps. First, Running Conditions Fretting Maps (RCFM) were plotted from friction logs, to determine the local loading of the contact surfaces under different external loads. The tribological degradation caused by the more detrimental fretting regimes (mixed regime) was then analyzed. Differences between the different fiber orientations are discussed mainly on the basis of the stiffness of the anisotropic material.

Identical external loads (normal load, forced displacement) were found to induce far different local loading in P and AP orientation because of the change in material stiffness. These different local loads resulted in different damage processes and velocity accommodation mechanisms. Analyzing differences in fretting behavior through material properties is therefore to be avoided, unless it has been verified that local loads are similar.

Composite Coatings With Metal Matrix Inconel 625 or TA6V Against Fretting Corrosion, Wear in Sea Water

93WS0690J Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 169-175*

[Article by Jean-Loup Heuze, Régis Baccino, DGA/DCN INDRET/CESMAN, La Montagne, France, and CEA CEREM, Grenoble, France]

[Abstract] This study investigated new composite coatings made of hard ceramic particles spread in a ductile metal matrix. The research aims to develop a coating material resistant to wear and fretting corrosion, with good ductility and toughness, for use in marine air and sea water. All deposits were made using the Plasma

Transferred Arc (PTA) process. An argon gas shield provided protection for the TA6V matrix coating.

The study focused first on two types of carbides—NbC and TiC—spread in an Inconel 625 (Ni-Cr22Mo9Nb3.5) matrix. The volumic percentage of the spread particles varied between 40 and 50 percent. This was followed by a study of carbides, borides, oxides, and nitrides spread in a TA6V matrix. The authors investigated the final structure of the composite materials, new phases (endogenous phases), the degree of dissociation of exogenous particles, and the distribution of those particles in the metal matrix. They assessed the material's toughness and brittleness using microhardness measurements. In a final step, the team tested selected coatings on an electrotribometer device in natural sea water.

High-Temperature Deformation, Fracture of Fiber-Reinforced Composites - Continuum Damage Mechanics Modeling

93WS0690K Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 176-184*

[Article by M. McLean, Department of Materials, Imperial College, Prince Consort Road, London, U.K.]

[Abstract] Many composite systems consist of aligned brittle fibers with high melting temperatures entrained in a ductile matrix of relatively low melting temperature. A model is developed that describes the time-dependent formation of a composite consisting of elastic fibers reinforcing a matrix that deforms by power-law creep. The theory uses the formalism of continuum damage mechanics to extend a simple stress-redistribution model for a continuously reinforced composite to encompass a range of additional factors including:

- end effects associated with short fibers;
- the evolution of various forms of damage associated with fiber fracture that leads to eventual macroscopic failure;
- the effects of fiber/matrix interfaces of different strengths.

Recent Progress in Carbon-Carbon Technologies

93WS0690L Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 191-196*

[Article by J.F. Jamet, A. Hordonneau, Aerospatiale Company's Space and Defense Division]

[Abstract] This paper surveys and assesses the current mechanical and technological characteristics of carbon-carbon composites to see how well they meet emerging needs in aerospace. The authors review the properties of C-C composites, the processes used to manufacture them

and their substrates, densification processes, and the various means of protecting C-C composites against oxidation. Applications to improve current or future propulsion systems and to develop new systems that can reuse launch vehicles are briefly discussed. The authors conclude that carbon-carbon composites are of potential use in future hypersonic engines. Given the state of the art, it may be possible to use them in the manufacture of large parts, and to protect them against oxidation. But the heat resistance of the oxidation protection and its expected life will have to be increased to meet propulsion needs. Carbon-carbon composites also have low ultimate strains, and this characteristic will have to be taken into consideration when the engine components are designed. Finally, since it is difficult to analytically simulate operating conditions, demonstrators that integrate C-C composites into the propulsion system will have to be developed.

Ceramic-Matrix Composites for Applications in Severe Environments

93WS0690M Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 203-298*

[Article by M.K. Hossain and R. Morrell, National Physical Laboratory, Teddington, Middlesex, U.K.]

[Abstract] Advanced composites based on glass and ceramic matrices are being developed for applications at over 1,000 degrees C in demanding high-technology products. This paper discusses some of the key issues and provides a brief review of testing and evaluation problems for CMCs. CMCs have the potential to meet important requirements for high-temperature materials, but there is a considerable amount of materials research to be done. Key goals for future work include: increasing the stability of fibers at higher temperatures; improving fiber-matrix interfaces for appropriate low-shear and oxidation-resistant behavior; developing cost-effective processing techniques; and devising reliable testing and evaluation procedures to increase confidence in products. In addition, links between design, production, and testing need to be strengthened to ensure commercial success.

Flexural Fatigue of Glass-Fiber-Reinforced Plastics; Testing, Modeling

93WS0690N Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 236-241*

[Article by P. Fournier, et. al., and Van Veelen, et. al., Ecole Centrale de Lyon, France, and Shell Research Center, Amsterdam, Netherlands]

[Abstract] This paper deals with the fatigue behavior of unidirectional glass-fiber-reinforced epoxy that was processed using the filament winding/molding technique. The epoxy is a standard or toughened model resin formulation (DGEBA/DDM). Two sizings were analyzed: a multipurpose one and a specific sizing, developed for epoxy-based composites.

A conventional three-point bending and a compression bending test showed that both higher interface strength and toughened matrices resulted in better fatigue performance.

Finally, the analogy that exists between failure mechanisms under monotonic and fatigue loading can be used to develop a non-time-consuming procedure to predict fatigue performance.

Processing, Microstructure of Pressureless-Sintered Silicon Carbide Platelet-Reinforced, Ceria-Doped Tetragonal Zirconia Polycrystals

93WS06900 Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 257-262*

[Article by A. Selcuk, U. Klein, C.A. Leach, R.D. Rawlings, Imperial College of Science, Technology and Medicine, Prince Consort Road, London, U.K.]

[Abstract] SiC platelet-reinforced 12mol%Ce-TZP composites were prepared following a processing route in which the constituents (20vol% SiC-Ce-TZP), mixed in aqueous media, were homogenized by ultrasonic dispersion to form a slurry, slip cast. They were then pressureless-sintered under argon atmosphere. The conditions of each processing step were optimized to yield homogeneous distribution of components and the best slip-casting properties. Slip-cast bar samples resulted in a green density of about 60 percent of the theoretical density (TD). The sintered density was typically 90 percent of TD. Microstructural studies of slip-cast samples, sintered in Ar, revealed a highly porous matrix with homogeneously distributed SiC platelets, oriented at planes parallel to the mold surfaces. The same studies also revealed surface cracks. The formation of surface cracks was related to the transformation of the tetragonal matrix to monoclinic zirconia and $Zr_2Ce_2O_7$, governed by the reduction of $Ce^{4+}(Zr^{4+})$ to $Ce^{3+}(Zr^{3+})$ at temperatures above 1,050 degrees C. The phase separation process was found to induce volume change, which results in surface cracks during sintering. The t-m transformation was irreversible even after prolonged oxidation treatments at 800 and 1,000 degrees C.

Wear-Resistant Solid Lubricants of Surface-Engineered Graphite Coatings on Ceramics, Composites

93WS0690P Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 263-268*

[Article by G. Sorensen, Institute of Physics and Astronomy, Aarhus University, Denmark]

[Abstract] Surface properties are important for the application of new materials and for the development of high-performance materials in severe environments. The present paper will discuss a new process (patent pending) for obtaining wear-resistant, low-friction surface coatings of graphite on a variety of substrate materials such

as ceramics and polymer-based composites. Friction is an important surface property, and there has in recent years been an increasing interest in solid lubrication. Powder materials with a layered crystalline structure, such as graphite and molybdenum sulfide, have found a number of industrial applications, and they have also been included in ceramic coatings and polymer inks in order to reduce the friction coefficient. Surface engineering has been used to modify surface performance, and a novel ion-beam burnishing technique has been developed for obtaining wear-resistant, low-friction surfaces. A suspension of graphite or graphite-containing polymer is deposited as a thin coating and bombarded with light ions or electrons. The coating cohesion was studied prior to and after the ionic bombardment. The crystalline structure of the coating was studied with reflected X-rays prior to and after the process. It was found that the number of (002) crystalline planes parallel to the surface was reduced, which reduces the wear of the coating. This paper will discuss ion bombardment parameters and how this novel process might be applied to ceramics and composites.

Newer Cermet Products

93WS0690Q Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 269*

[Article by J. Demit and G. Mavel, COSMAL and E X M Companies, Pouilly and Antony, France]

[Abstract] COSMAL has designed and patented an exclusive process for producing both known and newer ceramic-metal composites. The major steps of the process are: pretreatment of each raw material from homogeneous powders of appropriate particle size; thorough mixing of metal and ceramic powders and of a proprietary organic binder that can momentarily bind the powders without polluting the finished parts; forming through compression, extrusion, or injection molding; and final sintering with typical post-debinding shrinkage of about 15 percent.

Using a "hyper-greco-latin" experimental plan, the authors performed a detailed statistical study to assess the influence of alumina concentration, alumina type, and metal matrix additives in a common 40/60 stainless steel/corindon composite. The Snedecor test showed that each factor is pertinent with a probability of over 97.5 percent. The results highlight the importance of know-how both in terms of basic technology and fine composition adjustment when producing such composites.

Mechanical Properties for Discontinuous Fiber-Reinforced Aluminum Matrix Composites

93WS0690R Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 270-277*

[Article by C. Masuda, Y. Tanaka, J.J. Balette-Pape, National Research Institute for Metals, Tokyo, Japan]

[Abstract] This paper reviews the tensile properties, fracture toughness, and fatigue properties that have been reported for discontinuous fiber-reinforced aluminum-alloy matrix composites such as SiC whiskers and SiC particle-reinforced composites. Few investigations have been conducted, except for studies of the fracture toughness of SiC-particle-reinforced composites. Moreover, the data reported ranged widely. The authors suggest that international research collaboration to develop new mechanical test methods is extremely important if scientists are to gather reliable data for heterogeneous materials such as discontinuous fiber-reinforced aluminum-alloy matrix composites.

Enhancing Interface Bonding in Aluminum Trioxide/Aluminum Alloy Composites to Improve Their High-Temperature Properties

93WS0690S Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 280-285*

[Article by X. Liu, C. Bathias, P. Lefrancois, ITMA, Paris, France]

[Abstract] The authors studied fiber matrix interfaces in $\text{Al}_2\text{O}_3/\text{Al-5Si-3Cu-1Mg}$ and $\text{Al}_2\text{O}_3/\text{Al-7Si-0.6Mg}$ composites under several conditions. They found that the enriched Mg at the fiber-matrix interfaces in the as-cast composites actually consisted of compounds containing O. Ts treatment made the Mg dissolved in Al-base solid solution diffuse further to the fiber-matrix interfaces and homogenized interface structures, thereby improving the strength of the composites at high temperatures. The treatment did not, however, degrade the mechanical properties of the composites at room temperature. Fiber-matrix interfaces in metal-matrix composites play an important role in improving the high-temperature properties of MMCs. That means MMCs require strong fiber-matrix interfaces when used for automobile engines.

Effect of Coating Process on Weibull Parameters of Carbon Fiber Bundles for Metal Matrix Composites

93WS0690T Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 286-291*

[Article by M. R'Mili, et. al, G.E.M.P.P.M., URA 341, Lyon INSA, Villeurbanne, France]

[Abstract] Carbon fibers are very useful reinforcements for metal matrix composites, particularly aluminum alloy matrix composites. But it is hard to wet the carbon fibers at high temperatures using molten aluminum alloys, because they react to form brittle aluminum carbides that create areas of crack initiation and growth.

Generally, a surface coating is used to promote wetting and eliminate the fiber-matrix reaction during fabrication. Reactive chemical vapor deposition (RCVD) is

used to produce—and in this case study—the coating. This paper presents a study of carbon-fiber mechanical properties in which monofilaments, or bundles of 6K fibers, were used. A statistical study of the mechanisms of fiber failure was conducted based on existing models, and theoretical results were compared to experimental data.

The loose bundle test proved valuable for its ability to characterize carbon-fiber reinforcement and monitor changes in that reinforcement over the manufacturing cycle using only one test method. The 6K test is more representative because no selection is done, as with the single fiber test. Moreover, since the results give a mean value for the behavior of a large number of fibers, the test is more representative statistically.

Mechanical Characterization of Fiber-Reinforced Ceramics Using Indentation Testing

93WS0690U Nagoya *PROCEEDINGS OF JAPAN-EUROPE SYMPOSIUM ON COMPOSITE MATERIALS in English 01 Jun 93 p 318-323*

[Article by P. Kaspas, L. Carpentier, N. Chavent, Tribology and Systems Dynamics Laboratory, Ecole Centrale de Lyon, Ecully, France, and SORETRIB, Ecully, France]

[Abstract] The mechanical behavior of fiber-reinforced ceramics subjected to various stresses is related mainly to the behavior of their "phases", the matrix and fibers, and the fiber-matrix interface. Several techniques have been developed that provide information about the mechanical properties of the fibers, the matrix, and the interface.

One of them is an indentation technique to characterize the mechanical surface properties of homogeneous materials. It consists of monitoring the penetration of a (Vickers) diamond indenter into the material. The displacement and force of penetration are measured continuously during the test, producing an indentation curve. By modeling the loading and unloading curves, researchers can estimate the material's plastic and elastic properties by calculating its hardness and reduced elastic modulus (Young's modulus/ $1-\nu^2$ ratio). The technique is already used widely to characterize homogeneous materials and thin layers.

This technique coupled with an optical sighting system can be used to characterize the different phases of composite materials. The device developed by our laboratory can test a selected point on a polished surface with accuracy of greater than 1 μm . This report will present the results obtained on C/C and SiC/SiC composites with fibers whose diameters range between 10 to 15 μm . The technique will be described and the characterizations for the two composites reported.

AEROSPACE

Satellite to Satellite Communication With Laser Beams

937WS0579C Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 24 Jun 93 p 9

[Unsigned article: "From Satellite to Satellite With Laser Beam. DLR Presents New Research Results at Laser '93 Trade Fair at Munich"]

[Text] Munich. The laser is the basis for a future communication link with high rates of transmission between satellites. This is demonstrated by the DLR Deutsche Forschungsanstalt fuer Luft- und Raumfahrt eV, Koeln-Porz, at the Eleventh International Trade Fair for Lasers and Applied Optoelectronics Laser '93 which is taking place at this time in Munich. In this field coherent optical transmission will now be investigated. In this method a very stable laser with the aid of a phase modulator will be used in transmitting information using radiation at one of its frequencies.

At the DLR a search will be made for the possibilities for a new method for phase regulation of a local oscillator laser in an optical homodyne system. This method, called Synbit, will in the meantime be patented and will now be further developed together with industry for future applications in optical space communication, reports the DLR at Laser 93.

Laser technology is moreover of special interest in measurement technology, further reports the DLR. The enterprise since 1967 has been occupied in the development and use of laser methods for gas remote analysis from an aircraft. At present the DLR is at work on two dial lidar systems and an aerosol lidar system. "Lidar" stands for Light Detection and Ranging and "Dial" is an abbreviation for differential absorption lidar.

Using these systems it is possible to investigate propagation of power plant plumes, measure tropospheric water vapor fields and trace circulation in alpine valleys, but also determine the ozone profile in the stratosphere and measure polar stratospheric clouds. Since lidar methods are very well suited for covering extensive sectors of the atmosphere, it is just another step also to install a lidar system on a satellite in order thereby to be able to take in the atmosphere on a global scale, in the opinion of the DLR. The wind is a quantity influencing climate which previously had not been directly determinable from space. Despite its great importance for all atmospheric exchange processes it was previously not possible to determine the wind vector resolved in altitude intervals. Since a highly resolved remote global wind measurement system, however, is pressingly necessary, the DLR is working in international cooperation on the further development of a laser Doppler method, which is deemed very promising.

France: Very Large Telescope Developed for Southern Hemisphere

937WS0579D Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 24 Jun 93 p 8

[Unsigned article: "Schott Delivers Zerodur Telescope Mirror. The First of Four Mirrors for the Southern Observatory. Finishing in Paris"]

[Text] Frankfurt. The Mainz Schott enterprise on 25 June will deliver the first of a total of four Zerodur mirror holders for the Very Large Telescope of the European Southern Observatory. The production of this 22-ton heavy monolith with its diameter of 8.2 m began with its pouring 22 months before. Now the blank has cooled off and coarsely ground with a large 100-cm central hole. The 17-cm flat glass ceramic disk must be transported by ship in a special handling frame from Mainz to France. The Reosc enterprise in Paris is to carry out the finishing work.

Schott has developed a centrifugal casting technique for this new telescope mirror. In this method 45 tons of molten glass at a temperature of about 1600 degrees Celsius are poured into a metal form rotating at 6 rpm. Due to the centrifugal force glass mass soon covers the floor and a concave surface is gradually formed over the entire breadth of the mirror.

After a first cooling the large flat glass body arrives at a special kiln for controlled cooling in order to avoid cracks. After ten to twelve weeks the mirror is cooled sufficiently that for the first time it can be mechanically processed. This is followed by an eight-month curing in the warmth, during which the vitreous mass is transformed into a partly crystalline state, which imparts an absolute configurational stability to the mirror.

In addition to this thermal stability provision also is made for a new design principle for the best results, developed by the scientists of the European southern observatory. This adaptive optics method involves use of some hundreds of position elements which are mounted in the telescope beneath the glass disk and which keep the mirror in that ideal configuration which is calculated for the best observation results. This correcting mechanism will be automatically steered by continuous optical autocontrols of the mirror configuration and the observation picture.

This utmost optical quality will be supported by numerous measures. These include the optimizing of the mechanical boundary conditions of the telescope by means of a computer-steered fine motion, as well as the special shaping of the mounting and the sheltering structure in order to prevent air movements in the immediate neighborhood of the instrument.

With this new telescope, at the end of this decade, with erection in the Chilean Andes, a new jump in quality of celestial observations with earthbound instruments is

expected. The instrument will consist of four such mirrors, which together will form a 16-m instrument. The light-collecting surface will amount to 200 square meters. The apparatus will be erected on the mountain Cerro Paranal at an elevation of 2664 m. Meanwhile the first construction work has already begun there. The participating European countries invested about 500 million DM for the construction.

The scientists of the southern observatory for the first time in about four years—likewise in Chile—will test the New Technology Telescope using the new kind of telescope construction with adaptive optics. Already this instrument with its 3.6-m principal mirror has set a new international standard for the construction of such a large telescope. The first published pictures are no worse than those of the Hubble space telescope which circles the earth beyond the disturbing atmosphere.

The outstanding observational capabilities of the New Technology Telescope have induced Italian astrophysicists, on the occasion of the 400th anniversary of their university at Padua, to construct virtually a copy of this instrument and erect it on an extinct volcano in the Canary Islands. The 3.6-m diameter principal mirror will likewise be poured by Schott from the glass ceramic Zerodur and will be delivered by Zeiss after a one-year grinding process.

DARA to Encourage Small, Medium Enterprises

94WS0022A Duesseldorf HANDELSBLATT in German
6 Oct 93 p 22

[Article by TL: "Space: Research Expert Mennicken Succeeds DARA Director Prof. Wild; Information System Creates Incentive for Small and Medium-Sized Businesses"]

[Text] Bonn, 5 Oct—As of spring 1994, the German Space Agency (DARA) will make available an information system that is aimed at small and medium-sized businesses (KMU) in particular. DARA wants to provide an incentive through a special "marketing program" for the widening of the industrial base and to promote the development of markets through more competition, the new director of DARA, Jan-Baldem Mennicken, stated yesterday in connection with this at the science press conference in Bonn.

A special KMU innovation program in which 55 firms are to participate, 17 of them from the new federal states, will prepare small and medium-sized companies for participation in national and international calls for bids for space projects. Mennicken explained that this will create more competition. DARA wants to offer special seminars and workshops next year to help in the creation of more productive cooperation structures between small and medium-sized companies and the research sector. A special industrial conference in the new states in November will also be consciously aimed at small and medium-sized enterprises. Mennicken expressed the opinion that firms based in East Germany should be

integrated into national and international projects. This year DARA is going to provide a total of about DM53 million for this.

DARA's new director made it clear that the strained economic situation is having repercussions on the Space Agency itself. By and large, only the DM1.5 billion already estimated for this year will probably also be provided for the space industry in 1994. At any rate, this is how the government's blueprint for the economy in 1994 looks. Mennicken made it clear that the number of employees would also have to be "adjusted" from DARA's current 272 to this development.

DARA was founded in 1989 and is supposed to plan and carry out the space program in coordination with the federal government to internationally represent German interests. Mennicken is the successor of Wolfgang Wild, who retired from the post at the end of September. DARA is, to be sure, organized in the legal form of a limited company, but it is funded through commissions assigned it by those federal departments responsible for space. Critics find fault with the fact that the latter is at the present time only the Ministry for Research and Technology. Mennicken said that winning over other departments as well for DARA commissions is an important task.

According to Mennicken, talks will soon be entered into with the space industry on the future of the European space lab, Columbus, which has so far been in the planning. These will involve consideration of the fact that the European Space Agency (ESA) is to participate in the U.S. part of the joint space station recently agreed on between the United States and Russia. Preliminary decisions should be reached by 16 October and at the time the decision on the ESA budget for 1994 is made.

New German Earth Observation Camera MOMS Developed

94WS0022B Duesseldorf HANDELSBLATT in German
7 Oct 93 p 18

[Article by WDE: "Space: Earth Observation With New Camera; German Development Program Is Five Years Ahead of NASA"]

[Text] Bonn, 6 Oct—One of the most important experiments of the American-German space transporter-space lab mission is April of this year was of use in observing Earth with the "modular optoelectronic multispectrum scanner" (MOMS). This special camera was in operation for a total of four and a half hours and captured on film areas of Earth totaling 7 million square kilometers on four continents with several "scans" from an altitude of about 300 km and with a very high resolution of 4 to 13 meters. The German space agency, DARA, has now published the first pictures produced by the electronic MOMS Earth camera.

Despite the U.S. Landsat satellite, in use for 20 years now, and a few European, Japanese, and Indian Earth

reconnaissance satellites, there is still a great worldwide need for high-resolution color photos. The applications of these global views of continental areas for agriculture and forestry, landscape and city planning, and for disaster aid and environmental protection are diverse.

For many years Germany too has been participating in Earth reconnaissance, which is gradually also becoming a lucrative branch of the application of space research. An important project in connection with this is the MOMS sensor, which has already been successfully used once, 10 years ago, in a simpler version on board the U.S. shuttles, that is, the German space platform. With the introduction of the new MOMS six months ago, a new version of this electronic camera went into operation, one with improved and expanded optical and sensor systems that delivered even sharper black-and-white and color photos of the Earth's surface and even stereo photos. These data can be evaluated in various ways in appropriately programmed computers to produce three-dimensional relief maps of the photographed landscape. The MOMS pictures are suitable for many other earth sciences fields, for example, the establishment of the degree of ripeness or infestation of fields and forests and the discovery of environmental pollution on land, in rivers and lakes, or in coastal waters.

With the fantastic pictures it takes, the high degree of sharpness, and the spectrum range, as well as its stereo capacity, the MOMS-02 sensor is at least five years ahead of other Earth observation satellite systems, for example, the American Landsat or the French Spot. "The MOMS system is a gem of German Earth observation strategy," DARA managing director Heinz Stoewer said as he presented the current pictures.

The development of the MOMS-02 sensor was relatively cheap at DM30 million as against the billions that the Americans and the French spent on their Earth observation satellites. The German Aerospace Research Institute (DLR) and various users will spend another DM7 million for the evaluation and first application of the current MOMS pictures. But, by and large, what is involved with this optoelectronic scanner is an experimental Earth observation project.

Into Operation on Russian Space Station

A MOMS sensor will not be operationally deployed before 1995 and in fact on the Russian Mir space station. The electronic camera will then be in operation for a few years, taking high-resolution, multispectrum stereo pictures of the Earth's surface and transmitting them to the ground station in Neustrelitz. Furthermore, this orbiting position has the advantage over the American shuttle of a higher inclination to the equator (52°), so that nearly all of Earth's inhabited continental areas will come regularly within the MOMS sensor's field of vision. Then Germany will, after all, with Russian help still have a productive Earth observation satellite in orbit. This project will cost another approximately DM30 million

for the adaptation of the MOMS sensor and the application of the results. The Russians will also have access to these data, which is why they are not asking for any special use costs.

Problems of German Aerospace Industry Examined

94WS0022C Duesseldorf HANDELSBLATT in German 8-10 Oct 93 p 28

[Article by Anatol Johansen: "Space: German Industry in a Jam: Threatened With Loss of Volume"]

[Text] The German Space Agency (DARA) has acquired a new chief in a situation that is extremely difficult for it (HANDELSBLATT No. 193, 6 October 1993, p 22). Its director up to now, Prof. Wolfgang Wild—obviously annoyed—opted for early retirement because doubt is being cast on both the national German and the joint European space programs because of drastic cuts in funds for important parts of them.

The new director of the agency, 58-year-old Jan-Baldem Mennicken, who has up to now been in charge of space at the Research Ministry, views it as no easy task. He will hardly be able to prevent more layoffs in the already reduced German space industry. This is in connection with, among other things, the big European Space Agency (ESA) order that German Aerospace (DASA), which is part of the Daimler-Benz combine, was supposed to handle as the chief recipient of industrial orders under European cooperation.

What was involved was the construction of a large, just under 20-meters-long laboratory that would have flown freely in space and been provided with a large number of automatically conducted experiments. According to the original plans, another large manned cabin—the so-called Columbus module—was supposed to be added to it, a cabin that would have been added onto the American "Freedom" space station as a European component by the late 1990's.

The big order came to about DM8 billion and 38 percent of it was supposed to be filled by the German space industry.

After ESA's so-called Free Flyer (FF) had already been previously stricken from the Columbus program without a replacement because of the expense, now the Columbus cabin that was to be built onto the U.S. space station is also laid open to question by an agreement on the construction of a joint American-Russian space station. The volume of this manned module had already been reduced to less than half of the original 18 meters.

DARA director Mennicken indicated in Bonn that they are now thinking of turning this module into a reality in a European-American-Japanese cooperative venture, in which, however, experiences they have had so far lead

them to suppose that in that event the Germans would not exactly be assigned the filet mignons or the lion's share of the module.

This being the case, not much more of the order worth billions originally allocated for the Columbus project will be left for the German industry. On the other hand, as early as the end of last year the number of people employed by the German space industry had dropped to a modest 5,600. It is anticipated that another 780 positions will be eliminated by the end of next year—a blood-letting of another 14 percent, not taking into account the latest development in the Columbus program, which will probably force the industry to further reduce the number of highly skilled personnel.

In view of the difficult situation, what is now of importance to Mennicken is to keep the skilled labor force laboriously built up by the German space industry over decades from crumbling. The Federal Republic is today still able to protect the whole satellite technology industry and important parts of the manned space program. In view of the gloomy prospects, however, the best people are already beginning to look around for other positions outside of the space industry. But once the teams of highly skilled specialists are scattered to the four winds, the Federal Republic will have gambled away its capability and presence in an important branch of state-of-the-art technology and research.

Ariane V Test Delayed Five Months by Fuel Problems

94WS0049A Paris LE FIGARO in French
22 Oct 93 p 15

[Article by Jean-Paul Croize: "Ariane V Fuel Problems"—first paragraph is LE FIGARO introduction]

[Text] The process of fabricating solid fuel for the booster rockets has proven more difficult than expected. The development program for the future European launcher has been thrown for a loop.

The development program for the future European Ariane V has been thrown into uncertainty by the 5-month postponement of an important test, it has just been announced by CNES [National Center for Space Studies], the French space agency. Despite the setback, it still appears possible the giant launcher could make its first flight on schedule two years from now. But the hitch is still worrisome, as it stems from a problem in preparing one of the most critical elements of the rocket: the high-explosive solid propellant, a complex butaline and aluminum-based mixture that will fuel the boosters without which this rocket very literally could not get off the ground.

Initially scheduled for November of this year, the trial that has just been postponed was to be the first operational test of the boosters when fully loaded with 250 tons of solid fuel. Dubbed "M2" in rocket development parlance, the test has to be conducted at the Kourou

space center (French Guiana), on test-bed number 3, from which Ariane V is currently scheduled to blast off in October 1995.

Specifically, the test will consist of monitoring the course of a veritable controlled explosion throughout a firing sequence lasting a little more than two minutes, during which time each of the two boosters girding the main body of the launcher (whose single engine yields 100 tons of thrust) will deliver close to 500 tons of thrust—enough to lift off the ground Ariane V's total mass of more than 800 tons.

As CNES explained it, the postponement of "M2" was due to "the discovery of heterogeneities in the composition of the dry fuel." This shows that the Franco-Italian plant built for the purpose at Kourou is still having difficulty mastering a delicate operation: the molding of the three large "cakes" of fuel—the biggest ever made in Europe—which the Ariane V boosters are supposed to carry.

Risk of Explosion

With the largest of them weighing in at close to 100 tons, these "cakes," round in form and hollow in the center, must be absolutely homogenous. Examination of the two that were supposed to be used for the test next month revealed porosities that could have accelerated the rate of combustion. A disturbing phenomenon, since it could lead to jerkiness or surges during powered flight—or even worse, to a destructive explosion of the launch vehicle.

Anxious to avoid any risks in the development of this delicate facet of space technology (in January 1986, the American shuttle Challenger was destroyed by a booster explosion), the chief operations engineers decided to find out precisely why these porosities appeared before new fuel cakes are cast.

That meant postponing the test for an indeterminate period. But the hope at Kourou is that engineers will still be able to meet the deadline (about five months from now) for ground test "M3," which was supposed to follow M2, the test that has been postponed. M2 would then take the place of M3 in the Ariane V testing schedule. But if problems in fuel cake fabrication prove so serious that these two elements of the testing sequence cannot simply be switched, the future European rocket has little chance of starting its career at the appointed time.

EC: CNES Director Predicts Two 'Black Years' For ESA

94WS0057B Paris LE MONDE in French
27 Oct 93 p 15

[Article by Guy Porte: "Black Years for European Space Program"—first paragraph is LE MONDE introduction]

[Text] Though optimistic about the longer term, the director general of CNES [National Center for Space Studies] sees a painful period in the immediate future.

Nice—Jean-Daniel Levy, director general of CNES, presiding over a colloquium at Mandelieu (Alpes-Maritimes) on Saturday 23 October, labeled himself an "optimist" regarding the long-term future of the European space program. But in comments on the negotiations now under way to finance European Space Agency (ESA) programs, he opined there would first be "two black years, 1994 and 1995," as a result of Germany's and Italy's publicly avowed commitment to reducing their budgetary contributions (LE MONDE, 29 September and 17-18 October).

"Two years of slippage in our work, it's embarrassing from an industrial standpoint," he added. "But this isn't the end, because we're working for long-term objectives. The most important deadline arrives at the end of 1995. Between now and then, we will see what happens to the concept of the new R-Alpha world orbiting station, in particular whether our idea for a dual-access system for the station (one for crew and another for cargo) is or is not accepted." Mr. Levi owned his "disappointment" at the American's decision to focus on bilateral cooperation with Russia. He added, however, that "the discussions we have held with them show they are very anxious to preserve their partnerships with the Europeans, Canadians, and Japanese, if only to boost the political appeal of their program, which has generated considerable controversy in the United States."

"The launcher market," he noted, "is increasingly competitive. Not only the Russians, but also the Chinese and soon the Japanese. To me it seems inevitable, even desirable, that the Russians will over time increase their share of this market. But we still have several things going for us in this competition: the reliability of the Ariane, the high quality of our services, and the future Ariane V heavy launcher, which as of 1996 will be the finest launcher in the world."

DARA's Wild on German Aerospace Budget, Goals, Cooperation With Russians

937WS0603A Stuttgart FLUG REVUE
in German Jul 93 p 14-15

[Unsigned article: "The Chief of the German DARA Space Agency, Professor Wolfgang Wild, is Stepping Down Early; 'The National Budget Has Long Been at a Minimum'"; the first paragraph is an introduction]

[Text] The D-2 mission has ended. The world project Columbus also stands and falls with the American space station Freedom. In a time of empty treasuries the German Space Agency must take a new orientation. International cooperation, economy and a shifting of the center of gravity are the watchwords.

[Flug Revue] Herr Professor Wild, at the end of September you will depart from office; is that a declaration of bankruptcy because the establishment of a space agency has gone aground?

[Wild] The decision to quit has no relation to DARA. DARA has just recently gained in respect. My contract would have run out on 30 June 1994. That I am not remaining to the end has a matter-of-fact basis. Since we are engaged in discussions about the space station Freedom and since we must adapt to a still more difficult financial situation, have a new outlook on things. I think it is only right that he who is to head up DARA should get a grasp on everything as soon as possible.

[FR] The national space program is long overdue. Do you still therefore see a possibility for a fifth German space program?

[Wild] That I don't know; however, not in this legislative period, for sure not in my time in office, that time which I still have before me.

[FR] You once said that there must be a balanced relationship between ESA contributions and the national budget. You spoke of 40% for the national space program. Has your influence not sufficed in order to achieve this?

[Wild] It is indeed generally accepted by officials and parliamentarians that a share of 30%, that is, 600 million, for the national program and a little over 70% or 1.2 billion marks for the ESA is not the optimum ratio, but financial pressures and international obligations have led to this relationship.

[FR] Is such a large space agency necessary for this 30%?

[Wild] We have suffered consequences from this and a restructuring of DARA is envisioned with 290 specialists instead of the originally intended 350. In addition, DARA is not responsible for the national program alone. It must interact quite significantly with the ESA and is strongly involved in the restructuring of the American space station.

[FR] What will realistically take place with the German space budget?

[Wild] Normally we should have a growth within the scope of the inflation rate. But that will not be achievable in the years 1994 and 1995. NASA also adapting to a real fixed budget.

In the ESA the voices are multiplying that one must live with this. Should we would completely withdraw from space while our competitors did not do so we also would drop back technologically.

[FR] What is the minimum to which one could drop back?

[Wild] I think that in the national field we reached the minimum long ago. If we give up on the Hermes and make much smaller contributions to the space station the ESA program naturally also could be sunk. The manned flights in preparation for the space station have been considerably reduced. With the decisions made as of

now only the Mir joint flight is still foreseen; on the other hand, there will be no more Eureka flights and no Spacelab mission E1.

[FR] Are you disappointed that the original goal of a completely independent space agency, which would receive support from different sources, has not come about?

[Wild] To be sure. However, it is interesting that a commitment is now in sight, but due to the devastating financial situation it will again be delayed. There is the example of defense. Initially the defense people were completely disinterested in space. Today it has become otherwise and they have become fully involved. They are finding it very difficult to manage without the telecommunication and reconnaissance systems which are dependent on space. There also are applications in agriculture. The possibility of receiving reliable data on forest damage or monitoring idle areas has evoked interest. It is a tougher situation with telecommunications. The opinion of the telecommunication service was here entirely unequivocal that for such a country as Germany fiber optic cables were adequate. For navigation and air traffic control, on the other hand, increasing possibilities are evident.

[FR] The entire national space program is very highly dependent on the participation in the space station. What development do you see and could we still hang onto the Columbus concept?

[Wild] We could indeed do so both with version A, which foresees a very flexible construction of the station, as well as with version B, which continues the previous deliberations. With B the pressure to stick with the launch is relatively great. With version A it would be a 50-50 proposition. For us it would naturally be interesting if Columbus was kept intact and the Americans would give up their intention to construct their own work module. From the German point of view version A would be the best.

[FR] Would it not also be thinkable to cooperate with the Russians in construction of the Mir-2.

[Wild] It's only natural to talk about the Mir-2 being operated as a global station. That was the favorite idea of Minister Wissman. The opinions on this, however, are sharply divided. I have already expressed the opinion that we should cooperate with the Russians if it brings us a true advantage. But one should not make cooperation a supporting pillar of our space commitment. This same opinion also has been adopted by the other ESA partners and in America.

[FR] So the Hermes is indeed finally dead, because without participation of the Russians the Hermes project cannot be carried out.

[Wild] One can talk about how a space glider will be developed with the Russians, about the costs which are bearable. What the ESA has visualized for financing the

Hermes is after 1996 a real 5% growth of expenditures. I am not saying that Germany or another country can finance this. I therefore feel that is quite improbable that the Euro-Russian space glider will become a reality.

Swiss Build Nose Fairing for Ariane V Rocket

937WS0603B Stuttgart FLUG REVUE
in German Jul 93 p 33

[Article by Fred Richter: "Swiss Rocket Nose Fairing"; the first paragraph is an introduction]

[Text] After almost four years of intensive development work the certification model of the Ariane V payload fairing is being completed at the Eidgenos Aircraft Works at Emmen.

The nose of a booster rocket is formed by the payload fairing. Through its aerodynamically optimum configuration it protects both the transported satellite as well as the rocket itself from the frictional heat which arises when passing through the earth's atmosphere during the climb into orbit. In a typical launch at an altitude of about 110 km, even before the firing of the third rocket stage, it is divided into two halves and is separated at a velocity of more than 8,000 km/hour. The success in launching is dependent to a considerable degree on the precise separation of the payload fairing without contact with the rocket and satellite.

Switzerland is among the founding members of the European Space Agency ESA and is participating in the development of Ariane V with its share of 2%. As already with the Ariane IV and its predecessors it is Oerlikon-Contraves, Zurich, which is supplying the impressively large structure of the payload fairing. The certification model will now be completed at the Eidgenos Aircraft Works in Emmen. There they are responsible for the assembly of structural parts and the installation of all the subsystems. The aerodynamic measurements for determining pressure distribution will likewise be undertaken at Emmen.

New paths have been taken in the fabrication of the payload fairing for the Ariane V, especially with respect to the material. The previous fabrication from aluminum, used in conventional aircraft construction due to the lesser risk involved, has now been replaced by a modern and lighter, two-part fairing. It is fabricated from sandwiched acoustic elements with covering layers strengthened by carbon fiber and with an aluminum honeycomb core. Two versions are planned for Ariane V operation. A short variant with a length of 12.7 m and a free volume of 161 cubic meters and a long variant which will be needed, for example, at the launch of a polar platform, 17 m in length and a volume of 230 cubic meters.

Thus, it is not just a single empty shell which is involved. The payload fairing accouterments also include an electric measuring system for determining ambient conditions and the dynamic behavior of the half-shells when

they are cast off, which likewise will be developed and constructed at Emmen, a pyrotechnic separation system and a cooling and ventilation system.

The testing of the certification model, which now follows, constitutes an extremely important event. One of the most complex of the experiments provided for is the separation test. The principal objective is to test and certify, on the one hand, the process of separation of the payload fairing into two halves, and on the other hand, separation from the booster rocket. This test will be carried out in a vacuum chamber. One of the few installations with the necessary dimensions is located in Sandusky, Ohio, and belongs to the NASA Lewis Research Center. From time considerations aerial transport is indispensable. The size of the payload fairing and its containers make it necessary that the Antonov AN-124, the world's largest transport aircraft, be used for this purpose.

European Space Agency Presents 10-Year Plan

94WS0001A Paris LE MONDE in French
29 Sep 93 pp 1, 9

[Article by Jean-Francois Augereau: "Rough Sledding for Europe As a Space Power"; Subhead: "In Effort to Survive, European Space Agency, Rent by Crisis, Adopts New 10-Year Plan"]

[Text] A lot of people are wondering "if there is anyone piloting the aircraft," ever since the Granada interministerial conference in November that ended up again drastically revising downward Europe's space ambitions. The cracks surfacing a year earlier at Munich at the height of European solidarity, held up as an exemplar for nearly 20 years, simply widened.

There are many reasons for it. They range from the high price of German reunification to the devaluations of some European currencies and include the collapse of the Soviet empire and the worldwide economic crisis. The upshot is that each country has begun calculating on the basis of only its own interests. Occasionally some European countries even go so far as to question, under the guise of liberalism, use of the Ariane rocket to launch their satellites. One can only wonder about the future of Europe as a space power if the investments approved to develop that program that turned into a commercial success are taken into consideration.

Jean-Marie Luton, general director of the European Space Agency [ESA], is aware of this situation and upset about one day perhaps seeing the ESA turn into a hollow shell. He has begun working to tighten up things, slash budgets, and submit a new - the last? - plan for the next 10 years to offset policies lacking ideas and even opinions. To be sure, there is no question of challenging the acquisitions at Granada for the agency's scientific program and the earth observation programs.

Likewise, everyone was then delighted to think that the development of the Ariane 5 heavy launcher was well

along and that the flight of the first version on 1 October 1995 would surely be an occasion to celebrate. But disunity clearly surfaced over manned flights. Granada ratified termination of the Hermes space shuttle program endorsed by the French.

Granada also resulted in the downward revision of the Columbus program aimed at building a module that could be manned, the Attached Pressurised Module [APM], that was supposed to be grafted onto the American space station Freedom at the end of the century.

Unfortunately, because of budget cuts by the U.S. government, Freedom's schedule kept changing and its scope was scaled back. In June, it was down to a simplified version that the Europeans hoped would be the final one.

Unhappily, the changes were at Europeans' expense, since diplomacy has its obligations and the Clinton administration preferred to deal with Russia in the Europeans' absence. On 2 September it signed two agreements with Russia.

The first deals with authorization provided for a certain number of Russian rockets to launch western satellites. The effect of this action is to undercut Ariane, a formidable rival of the U.S. launchers. The second seals with joint creation of an international manned space station (project Alpha), built around the future Russian laboratory, Mir 2, and a module of the former Freedom station. One day Japanese, European, Canadian and even Italian components could be grafted on to it.¹

From Shuttle to Capsule

One expert bitterly remarks, "We have been had just like every time we are not strong and determined." This was clearly shown in the past. Americans only respect strength and only cooperate with the strong. "Absent that, they consider us at best as equipment purveyors."

What Luton proposes in a plan that the Europeans will debate at the agency's council, 12-13 October, is a way to combat this state of affairs.

The recipe is simple. Making it work is difficult. It is: do better with a lot less. Luton's services kept only 18 billion units of account [UA] out of the planned UA22.7 billion² stipulated at Granada for financing the agency's space activities during the period 1993-2000. This restored budget credibility is the price of member states participation in ESA.

As the agency's leading underwriter, France is unwilling to accept everything and above all envisions "useful space" before wondering about "the adventure" of manned flights. With the change in Germany's administration, a space defender was lost since the research minister is no longer Heinz Riesenhuber, but others were won at the chancery and the finance ministry, provided the country's space budget does not exceed DM1,172 million.

Italy was spending lavishly, thanks to loans. It will now have to settle for the 800 billion lire from its budget allocation and cross out the 1,200 billion lire it was getting from the banks.

Therefore the agency is proposing to its members "the refocusing" of what remains of the Hermes program and "the redefinition" of the Columbus program's module that could be manned.

On the first point, ESA recommends to those who are willing to try for adventure to get into the Manned Space Transportation System [MSTP] program aimed at in-orbit servicing of space stations with regular cargo and astronaut transports and working on them for some operations. The program consists of four projects. UA100 million will be committed in 1994 and 1995 for: the Crew Transport Vehicle [CTV], a kind of "huge, modern" Soyuz able to transport persons and materials and that the Europeans "will accomplish by themselves"; the Automated Transfer Vehicle [ATV], a smart service module needed for orbiting and rendezvous operations of the CTV and the redefined APM; the Extra-Vehicular Activity [EVA]-2000 Space Suit, a joint ESA-Russia³ project that is supposed to lead to the creation of a new sort of space suit; and, lastly, the External Robotic Arm [ERA], a robot arm about 10 meters long, derived from the one developed for the former Hermes program.

On the second point, redefinition of the Columbus program, the agency is proposing a scaled back version - already the second one - of its APM with its size, 8.5 meters, and weight, about 10 tons, dramatically reduced.

The results are: a 27 percent lowering of costs that, in six years (1994-2000) will drop from UA2,596 million to UA1,892 million; slippage of the schedule by several years; but launching in 2002 by the Ariane-5 rocket while the APM was supposed to be installed in the shuttle's cargo bay in 1999.

What will become of these proposals that aim at "keeping Europe from being put on the sideline?" Luton is trying to remain optimistic and hopes that by December, the agency's member states "will confer their blessing on the baby" and it will then be up to the respective ministers to get the machine fully off the ground at an interministerial conference in 1995. As one specialist remarks, "Two years will not be too much for unraveling the technical problems presented by the new programs and to clarify the position of each on the international station."

American Dowry

He adds, "But all that is changing so quickly. Six months ago, cooperation with Russia was the solution for all our troubles. The Europeans were going to rehabilitate Mir, take part in Mir 2 and "ponder" a joint station to be created between 2005-2010. Today, Washington is courting Moscow and signing off on the Alpha station

with Moscow, including in the bridal gift a \$100 million endowment over four years for Russia."

It is no surprise that the Americans are nervous, since Europe is planning to replace the Russian station's on-board Data Managing System and to upgrade its communications system via the Data Relay Satellite [DRS].

Therefore the game promises to get rough if Europe stays on. But it will make sense only if the Paris-Bonn tandem plays its part as locomotive. Then, and only then, will the future of humanity in space make sense for Europe. As Luton states, "We must not throw in the towel. In the seventies the U.S. had done practically everything in the space sector. Should we then have invested in scientific satellites, in telecommunications satellites, in launchers? The follow-up shows the answer was affirmative. Europe does not require \$14 billion a year to succeed. What it needs is to march in unison with reasonable resources."

From Capsule to Laboratory

The ESA's manned flights project clusters around two programs:

The Manned Space Transportation Program (less than UA2 billion) should result in the creation of two spacecraft, the CTV and the ATV. The CTV is a modern capsule, far removed from the Hermes shuttle and its UA7 billion, that is not reusable but is able to transport a crew of at least four persons and simultaneously carry 500-1,500 kilos of cargo. Although affording limited maneuverability, it would be capable of tilting sideways to enable a landing precision of 3 km maximum compared to the 40 km of a Russian Soyuz.

The nearly 10 ton craft, joined to its service module, the ATV, would use up practically the full capacity of the Ariane-5 rocket, or nearly 18 tons for a 51 degree inclined orbit. Two qualifying flights are scheduled between 2001 and 2002, the first without crew and the second with crew. The capsule's first operational flight could occur in 2003.

European industrialists are going to consult on this concept which also is nagging the Russians who are anxious to replace their aging Soyuz with its limited payload and the Americans who are wondering what comes after the shuttle. Two studies are supposed to be initiated on this topic in November.

The ATV, in turn, is a smart multi-mission service module providing thrust and rendezvous operations for the payloads (CTV and APM) whose orbital placement it is supposed to ensure. Development of this system that will sort of serve as a final stage for the Ariane-5, should broadly benefit from the work undertaken on Hermes five years ago. Its maiden qualifying flight could occur in 1999.

The Columbus program should lead to the building of the APM designed for grafting onto the U.S.-Russian station someday. The program was initiated many years

ago already but has been revised downward. It envisions the building of a module that could be manned and christened APM-5. It weighs 10 tons and is able to accommodate a payload of between 1.7 and 3.4 tons. At best, it could be launched by Ariane-5 in 2000, but more likely in 2002. Its development, which has been extended until 2002, is supposed to cost UA2.3 billion.

Footnotes

1. Besides the fact that the agreements concluded between The U.S. and Russia are a weapon against Europe, they also allegedly are the outcome of tough bargaining on the halting of supplies by Moscow of sensitive materials or technologies to countries developing or on the verge of developing nuclear weaponry.

2. That is, approximately FF159 billion. The unit of account is worth about FF7.

3. Europe would still like to develop its cooperation with Russia. But that country's lack of financial wherewithal makes it difficult to embark on joint projects. Despite everything, ESA has planned to conclude contracts worth UA110 million over three years. Half of the credits have already been expended.

French Aeronautics Industry Assessed

93W50730A Paris LE MONDE in French
13 Sep 93 pp 1, 11

[Article by Jacques Isnard: "French Aeronautics Industry's Concerns"; Subhead: "U.S. and Russian Commercial Aggressiveness at Root of Possibly Catastrophic 1993-1994"]

[Text] French civil and military aeronautics manufacturers are noticing an unprecedented worsening of the competition on world markets. They are confronting a Clinton administration that has decided to use the NASA and Pentagon budgets to safeguard the interests of U.S. aerospace industrialists. They are also facing an "all out" commercial offensive by Russia to export. They project that "1993 and 1994 could be catastrophic and today's extant industrial framework will quickly collapse unless the government takes up the dual challenge."

First, the U.S. challenge. It is common knowledge that the U.S., under the GATT negotiations, has called into question the agreement reached last year with Europe on direct and indirect government assistance to manufacturers of wide-body aircraft. Since then, three fresh events have occurred that add to the confusion and indicate that the aeronautics sector has become a free-for-all.

First and most recently there was Bill Clinton's initiative authorizing NASA and some federal laboratories to use public funds to work on behalf of private companies. For instance, NASA supposedly will spend \$1 billion over six years to develop executive aircraft, benefiting groups like Learjet or Cessna. This has been roundly denounced by Dassault Aviation.

Objects one high-level officer at Dassault-Aviation that manufacturers the Falcon line of executive and connector aircraft, "That is tantamount to assisting them annually to the tune of FF1 billion."

The second event goes back scarcely several days and was revealed by the weekly specialty publication, AVIATION WEEK AND SPACE TECHNOLOGY. It was a telephone call that the U.S. president made to the king of Saudi Arabia. Clinton asked King Fahd to have the Saudia airline purchase about 60 American aircraft (from Boeing or McDonnell Douglas) using a \$6.2 billion Export-Import Bank loan, that is, nearly 85% of the amount of the contract. "There is no Mr. Europe able to swing that kind of deal," is the bitter remark at Airbus Industrie.

Political Decision

A third event went unnoticed. It involved last week's submission by the Pentagon of its plan for reorganizing trans-Atlantic armed forces.

As some French observers point out, U.S. Defense Secretary, Les Aspin, conducted the restructuring with one rather special concern, namely, to save as many jobs as possible in the industry, using artificial means if need be to hold onto activities in danger of waning. Just to mention one example: the U.S. Air Force was supposed to stop ordering F-16 and F-18 aircraft, but the assembly line will remain open for export customers that might not want to procure the heavier, more sophisticated and, therefore, more expensive successor (the F-22) of those aircraft. Similar nudges will be provided to safeguard the defense industry where market laws would rather encourage giving up the programs and where budget cuts might entail the elimination of 800,000 jobs before the end of 1996. "At the Pentagon, we would like to enable the economy to create jobs and to be even more competitive internationally," is how Defense Secretary Aspin confided his explanation of it.

It is necessary to add to this high-level political decision what the French Aeronautical and Space Industries Group [GIFAS] spontaneously designates as the "manipulations" of the dollar, the sector's benchmark currency. In his yearly report, that has just been published, GIFAS' general director writes: "Competition is worsened by a dollar exchange rate that remains considerably less than its economic value (20-25 percent)." This gives the Americans quite a leg up from the outset.

The U.S., however, is not the only challenge hurled at the French. Russia too is far from having spoken its final word in this strategic activities sector.

Between 8-15 September, in fact, at Nizhny Novgorod, east of Moscow, Russian industrialists are hosting a week-long show. The show allegedly is not only an assembly of aeronautics exhibitors. It also is an assembly of weaponry companies—all categories intermingled—at the express behest of the Russian government that has

just launched an energetic worldwide promotional campaign since it does not plan, despite the economic realities, to resign itself to shutting factories and reconverting others or engaging in massive layoffs.

Dumping Prices

In France, at the General Delegation for Weapons [DGA], that just dedicated a complete issue of its magazine, *L'ARMEMENT*, to technological cooperation with the eastern countries and the Russian defense industry¹, there is no hiding the fact that, after five years of political upheavals, Moscow is making a strong comeback on the international weapons stage. "Russia badly needs foreign exchange to successfully reconvert its military industry to civilian activities," writes Frederic Couvert, attached to DGA's international relations delegation. "Well, it is precisely the military-industrial sector that is most able to bring in such foreign exchange since weapons constitute the bulk of exportable goods." He also wonders, observing Russia's current market efforts, primarily aimed at the third world: "Is not an active export policy the prerogative of the major powers?"

To position themselves, the Russians have no qualms about engaging in dumping prices. A Sukhoi-27 aircraft is offered for \$30 million. Its U.S. rival, the F-18, is offered for \$45 million. Compared with an American F-16 (\$40 million) or a French Mirage-2000, nearly \$30 million, a Mig-29 "is worth" \$24 million. The latest T-80 tank goes for \$3 million while the U.S. Abrams is on the market for \$5.2 million.

Couvert does remark: "It is a fact that Russia's present instability could threaten after-sales service and maintenance of the Russian equipment."

That could cause some customers, who traditionally demand "ironclad" guarantees, to think twice. You get along as best you can is the way French industrialists basically respond to this. For that argument does not apply to rivalry from the U.S. And in competition from Russia, potential buyers do not hesitate to play up the cost differential to get further price cuts on the equipment offered under contract by the French.

Footnotes

1. *L'ARMEMENT*, number 38, July-August 1993, FF65.

Recapitalization of French High-Tech Public Companies Discussed

93W/S0730C Paris *LE MONDE* in French
18 Sep 93 p 27

[Article by C. M. [expansion not given]: "Bull, Air France to Split Nearly FF15 Billion"; Subhead: "Recapitalization of Public Companies"]

[Text] On Thursday, 16 September, Edouard Balladur promised that the French government will furnish a "sizable amount" of capital grants to "some public

sector companies." That was the very day Bull, Thomson, National Aircraft Engine Research and Manufacturing Company [SNECMA], Giat Industrie—government-controlled companies—announced or confirmed massive layoffs and in the wake of Air France's announcement of a drastic program to eliminate jobs. The message is unmistakable. The mini-budget had already brought to FF16 billion the budget earmarked by the government for capital grants. And there is question here of inviting criticism. Balladur's intent was to signify that the government will not remain inactive, even if it plans to privatize.

Even if? It is precisely because it plans to privatize that the government is going to have to earmark sizable amounts for its shareholder responsibilities, in the context of rather difficult budgetary arbitrations. It will also have to play emergency rescue service. None of the following can expect much: Pechiney, suffering with its aluminum; Thomson, routinely expecting a mass market for its electronics; Usinor Sacilor, experiencing a dreadful economic situation in iron and steel. The priorities have been established. First there are "two fires to put out": Bull and Air France, whose financial situations are by far the more critical. Aerospatiale should probably be added to them since it is at the top of the defense ministry's list of priorities. Those three public companies alone could use up a good FF15 billion.

The required recapitalizations for the others will take other approaches apart from the budgetary route. Alliances, for example, on which the ministry of industry is actively at work. An excellent exemplification of this could be furnished by the marriage of Pechiney and the well-endowed National Research Center [CNR], that mention was made of.

Eurocopter-British Aerospace Venture to Produce Helicopters

93W/S0730D Paris *LE MONDE* in French
8 Sep 93 p 24

[Article: "British Aerospace to Ally with Eurocopter for British Helicopter Market"]

[Text] British Aerospace is going to create a joint company with the French-German Eurocopter consortium to respond to a British army invitation to tender for the purchase of nearly 100 anti-tank helicopters to replace its Lynx. A decision from London is expected by this October or November. Eurocopter is offering its Tiger vis-a-vis an offer from the U.S. McDonnell Douglas group that has agreed to entrust the British Westland company with production of the Apache helicopter. By allying with a British partner, Eurocopter and McDonnell Douglas hope to win over London's decision makers.

France: Capabilities of SPOT III Satellite Reviewed

93W50730F Paris LE FIGARO in French
24 Sep 93 p 9

[Article by Jean-Paul Croize: "SPOT III Satellite: All Purpose Eagle Eyes"; Subhead: "Civilian Applications for Space Imagery Undergoing Major Development. Allied to Virtual Imagery's Data Processing Power They Enable, for Example, Visualizing Landscape Modifications."]

[Text] Kourou—Except for some last minute glitch in the countdown operations that were proceeding normally yesterday evening at the Kourou space center in French Guiana, Europe's Ariane rocket should put into orbit very early today (between 0327 and 0345 hours) a genuine constellation of six scientific or technological micro-satellites as well as the French SPOT III satellite worth nearly 800 million French francs [FF].

It is an important launch since this third version of the family of civilian remote sensing vehicles that our country has developed since 1986 in cooperation with Sweden and Belgium, constitutes the new link in one of the most promising applications of the conquest of space. Satellite photos, currently in the form of video, are experiencing a "rash" of new applications, all of which are equally amazing.

Rendered infinitely "manipulatable" through data processing, the views are currently turning land cartography as well as urban improvement or national and regional development topsy-turvy.

With a total investment that presently approaches FF8 billion, France has been able to raise itself to top international standing in this sector, based on this program that was unfurled more than 20 years ago.

On the video display, the view seems to have been shot from a helicopter and clearly shows the rectilinear groove that the highway cuts into the forest. One of the local environmental protection officials squirms in his seat and cannot refrain from grimacing. The small valleys that he is so familiar with are positively disfigured. While focusing the view on a rest area near the exit ramp for the highway connection, one of the project's advocates tries to argue: "Look, a thousand trees are going to be replanted here."

But nothing doing, that does not go over. The owner concedes: "Well, the course of the highway can be shifted four kilometers northwards. That will extend its length but it will spare the wooded area, if you really insist on it." Three minutes of typing on the computer's keyboard, a few movements of the "joystick," similar to those for video games, and the display shows an overflight of the same hills but with a roadway that disfigures the landscape much less. From the sigh let out by the mayors of the affected communes, the project's officers know that the battle is over. A half hour of video presentation made

it possible to circumvent months of vacillation. "And hundreds of thousands of francs spend on making various sketches and drawings that, moreover, would not have afforded a tenth of the realism offered by this new application of remote sensing from space," assert experts from the National Center for Space Studies [CNES], the French space agency under whose aegis the SPOT system has been developed.

Agricultural Monitoring

For the connection between the preceding scenario—which is no longer fiction—and the space program is that 90 percent of the images used to optimize the trajectory of that future highway connection are derived from the space program. According to a principle presently used both by the Departmental Equipment Directorates [DDE] for road work and by the French power company [EDF] to visualize the installation of its high voltage lines, they are based on the manipulation of "ground altimetric reliefs" supplied by the French satellites. In addition to SPOT's ability to reveal details of nearly ten meters on the ground—a world record in this regard since the U.S. LANDSATs do not view items less than 15 m—they are each equipped with two identical filming instruments, thus providing them with binocular vision (they are able to scan at an angle, tracing a 27 degree angle to the vertical).

As Gerard Brachet, CEO of the SPOT Images company, explains: "With those satellites, not only is relief photography performed, but the terrains are positively restored in three dimensions, by overlaying them with any virtual element whatsoever."¹ A number of major new applications are therefore to different sectors of activity.

First, there are the agricultural applications that are developing apace (25 percent increase annually). Naturally, this entails conducting research on the wellness of the plants based on their radiations in certain very specific wavelengths that the satellites successfully differentiate. But this sector also encompasses an enormous amount of census, cadastral and monitoring activity connected with activities in rural France. One of many instances: Satellite data have been used for the four years of the continued drought in Europe to monitor requests for indemnification formulated by farm operators. With the data gotten from space and stored on the ground in magnetic storage, simple computer processing is enough to determine whether a given parcel really had been scorched for lack of water or whether, on the contrary, at the time of a declaration, the parcel contained vegetation in perfect condition. They will soon enable monitoring of the actual fallowing of the lands decided upon under the Maastricht agreements.

Virtual Images

But 35 percent of the shots taken by the SPOT satellites henceforth will involve cartography in the broad sense. They will especially make it possible to create quite futuristic "space maps" on magnetic tape. Christened

GEOSPOT, these are electronic relief "map foundations" that can be overlaid on other computerized mapping documents. Virtual image technologies make it possible to add on to them, at will, in the most realistic fashion possible, the details whose impact on the ground one wishes to assess. "We are going to see a lot of development in requests from civil engineering and the public works and building industry," remarks Gerard Brachet, who projects a bright future for such applications, grouped under the generic designation of "geographic data systems."

So far more than three million "scenes," shots, each of which covers a 60 km by 60 km square area on the surface, have been supplied by the first two SPOT satellites put into operation in February 1986 and in January 1990. Their data have been used by upwards of 60 countries around the world. Even by the U.S., whose government, it may be noted, has just purchased "several million dollars worth of SPOT imagery," CNES crows.

In the present estimation of Rene Pelat, CNES chairman: "We had to venture getting into this sort of project, after what had been done abroad in the sector of military observation." Actually, in France the process was the opposite of the two super powers. While in Russia and the U.S., civilian earth observation constitutes a diversification of techniques developed for defense needs, in Toulouse, at Matra-Marconi Space, France is presently putting the finishing touches on two spy satellites called "HELIOS." Designed as a technological extension of the SPOT satellites, they should make it possible to maintain on future civilian satellites, slated for the end of the century, the technological progress made by our country in recent years.

Footnotes

1. SPOT Image was set up in 1982 by CNES, organizations and industries linked to the development or operation of SPOT (primarily the national geographic institute, the main user, and the Matra group, engineering project manager for the program). It currently has three subsidiaries overseas (in the U.S., Australia and Japan) and employs 135 individuals at Toulouse. The firm has just celebrated its first FF1 billion in turnover.

Commentator Questions European Role in Freedom Space Station

93WS0712C Frankfurt/Main FRANKFURTER
ALLGEMEINE in German 9 Sep 93 p 1

[Article by Gauunter Paul: "Put Out of the Running in Outer Space"]

[Text] The Freedom international space station that America wanted to build with Europeans, Japanese, and Canadians taking part was, constantly manned, to have orbited the earth already in the Year of Columbus, 1992. An equal partnership was aimed at here, negotiations about which went on perseveringly for years, until finally agreements accepted by all sides were signed. However,

for the most part there has been no sign of an equal partnership in action. The American plans for Freedom have been changed again and again without any consideration for the participants. The vice president of the United States, Gore, and the Russian prime minister, Chernomyrdin, have now signed in Washington an agreement on a new joint space station in which the Americans' partners are no longer taken into consideration at all. But it has been agreed, it is reported unofficially and totally without formal commitment, that the Europeans and Japanese will be somehow included at a later phase of development—after an American laboratory unit docks at the Russian Mir 2 base station in January 1997. There is no longer talk of equal status.

The latest development comes in a phase of uncertainty that, in any case, has existed for some time now. That is, the costs for Freedom had gotten out of hand in a way that gave rise to doubts concerning the soundness of the plans. President Clinton had to ask NASA only a short time ago to trim down the space station—and this was not the first time. Several European countries are no longer nearly willing to bear the heavy financial burden without protest.

Federal Research Minister Krauuger has announced that he wants to cut by 1.2 billion German marks [DM] this year the German financial contribution for the European Space Agency, ESA. The already trimmed-down European "Columbus" contribution for the international space station would be mainly affected by this. At the last ESA meeting several member countries reported that financing of their laboratory unit is no longer ensured. It was necessary to make do with interim financing and to postpone definite decisions.

The uncertainty has increased further with the American-Russian agreement. At present no one on this side of the Atlantic knows how Columbus, for whose development considerable money has already been spent, fits into the new plan. It is rumored at DARA [German Agency for Space Affairs] that it is possible that the Europeans will have to define their contribution anew. ESA, just as NASA, is now waiting for Gore's comments on what he actually settled on with Chernomyrdin then. It will probably be several weeks before the new agreement can be assessed.

All in all, there is the question of what sense it really makes to spend money for the scientifically unnecessary project of an international space station if its planning is going into thin air. When President Reagan approved the construction of such a station for \$8 billion at the beginning of 1984, at least a target appeared to be defined. From the beginning the galling part was that Freedom was always regarded as a national facility in the United States, in spite of the later agreements that provided for an equal partnership with the Europeans. Even now the United States—perhaps more than ever—

is of the opinion that Europe must help it ensure and strengthen its leading role in space.

It is likely that this goal is permitted to cost America something—although there too economizing is necessary. Otherwise it would really not be comprehensible that on the other side of the Atlantic the development work for the space station has already swallowed up more than the \$8 billion originally granted. For the Europeans it was important to begin with that they saw the opportunity to develop their own manned space infrastructure and to become independent in space with Columbus, the Hermes shuttle and the Ariane-5 rocket. For coflights they depended at that time on NASA's monopoly, which was paid well for these.

The situation has changed steadily since the collapse of the Soviet Union. The Europeans can—if they want to—send astronauts to the Russian Mir station too. Lower prices for manned space flights are hoped from this competition. Europe basically no longer has a need for its own potential.

In the last few years the Europeans have signaled time and again that they support the inclusion of Russian capacities in the plans for the international space station. Washington appears to have interpreted this in an odd way. The European Space Agency, ESA, has of course not said that it and its member countries no longer have any interest in the project. They only wanted to suggest that the plans could perhaps be carried out even less expensively.

If the development of a space station starts from the beginning again and the Europeans face substantial additional expenses as a result, without their being granted a more important role than that of financial participants or of junior partners largely without rights, in any case the sense of the undertaking will have to be thought about once again—that is, far more thoroughly than thus far, not to mention the basic misgivings about manned space flights.

Italy: Interministerial Committee Assesses San Marco Launcher

*MI1410133593 Rome SPAZIO INFORMAZIONE
in Italian 15 Sep 93 pp 4-5*

[Text] The CIPE [Interministerial Committee for Economic Planning] held its last meeting on 3 August. At this meeting it decided to set up a commission to study the technical and economic aspects and the international collaboration connected with the development and planned improvement of the San Marco Project. This project was the brainchild of the famous Prof. Luigi Broglio some 30 years ago and is being managed by La Sapienza University of Rome. The decision was made as a result of a specific proposal from University and Research Minister Prof. Umberto Colombo. Sergio Ristuccia, a magistrate at the State Audit Court is the

president of the commission, the other members being Alessandro Minuto Rizzo, Prof. Francesco Carassa, Dr. Gianfilippo Cuneo.

On the basis of the decision made by CIPE, this commission has been given the task of:

- 1) Estimating the size of the future market for small satellites with reference to equatorial, inclined, and polar orbits in terms of requirements and the associated launching costs;
- 2) Evaluating the corresponding requirement for launchers, subdivided according to the classes of payload capacity and costs, and the opportunities for Italy in the sectors of the market that are open or accessible to us;
- 3) Calculating the importance of continuing to have an autonomous capacity to build launchers, a launch site, and the relevant services;
- 4) Verifying the content of possible international alliances at an industrial level, and at an agency level, with particular reference to collaboration with American industry as far as launchers are concerned and with France, possibly in connection with the ESA, for the launch site;
- 5) Identifying, as far as possible, the times and costs involved in the achievement of individual objectives, including an indication of the most suitable working and contractual methods for the realization of the project. This would nevertheless assure that a number of Italian companies would be able to contribute to the initiative. Moreover, clarifying responsibilities and defining specific terms regarding the amount of public funding to be employed, and the funding times;
- 6) Verifying the methods and conditions for the effective involvement of La Sapienza University of Rome and industries in the sector from the initial phase of the project on.

The Ristuccia Commission, which met for the first time at the beginning of September and will finish its work by the end of October, will present a report to the University Ministry. Therefore, by the end of the year Minister Colombo should present CIPE with a detailed proposal on the future of the San Marco Project.

Italy: Government Funding Insufficient for Space Activities

*MI1410120793 Rome SPAZIO INFORMAZIONE
in Italian 22 Sep 93 pp 2-3*

[Text] Tension is high and those involved in the Italian space sector are worried. In fact, up to now, the "sickle" of austerity had only passed lightly over national programs in the space sector. Now drastic cuts in funding for the activities of the ASI (Italian Space Agency) and in funding for participation in the ESA (European Space Agency) projects seem inevitable. As far as Spazio Informazioni understands, the 1994 finance bill, which is

currently being examined and approved by parliament, has only budgeted 800 billion lire for space activities and, at first, the government had even hypothesized a budget of only 750 billion lire. University and Research Minister Prof. Umberto Colombo announced to the assembly of the Association of Aerospace Industries before the summer vacation, that he would be asking for 850 billion lire in funding for the coming year. This news would mean that he had not managed to get his request accepted. This 800 billion lire would assure the same level of funding as for 1993. This is dramatically insufficient, considering that our country's obligations to the ESA alone total about 824 billion lire and also that the ASI has established that a good 1.314 trillion lire in funding would be needed for the coming year for the 1990-1994 National Space Plan approved by the CIPE [Interministerial Committee for Economic Planning]. This is not all. The situation is even more worrying if one considers that the 1993 budget provided for 2.5 trillion lire in overall funding for space activities over the three years 1993-1995 and that the total obligations already taken on by the ASI up to next 31 December total a good 3.5 trillion lire. A further 500 billion lire at least must be added to this amount because of the devaluation of the lira with respect to the other European currencies and the ECU.

It is understandable that tension is rising in this situation. According to those working in the space sector: "This is not a joking matter and could lead to bankruptcy." In effect, considering the financial problems and those resulting from international collaboration, the decision of Minister Colombo to appoint Giampiero Puppi a commissioner for the ASI has not had any calming effect yet. On the contrary, this period of extraordinary management is definitely traumatic but understandably necessary at this time. Unfortunately, it is taking place at a delicate time when something must be done quickly in order to avoid a situation that could become irreversible. Commissioner Puppi took up his position in the Rome offices of the ASI in Via di Villa Patrizi at the beginning of September. He immediately covered his activities and decisions with an impenetrable and equally inexplicable veil of reserve. What is more, this reserve seems to apply especially to the press. Therefore, no information has been given from that date to the present time. The Ministry of [Research and] Universities has issued a note stating that Puppi is to prepare "suitable modifications to the law that set up the ASI." Alternatively, if he considers it more appropriate particularly as far as speed is concerned, to resolve the matter with clear directives regarding its interpretation from Minister Colombo, possibly having heard the opinion of the Council of State. The note states that Puppi considers the four-month period he has been given as sufficient. There are a number of other urgent problems on Commissioner Puppi's desk. These include the reorganization of the whole agency, the definitive launching of regulations governing its organization, the updating of the PSN [National Space Plan] (which as he has said himself, had already been started by former ASI

President Prof. Luciano Guerriero), and also the solution of the well-known discordancies both inside and outside the agency, also at a legal level. Furthermore the new director general of the ASI should be nominated as soon as possible (Prof. Carlo Buongiorno's term of office already having expired), and finally Minister Colombo will certainly renew the terms of office of the president and of the board of directors, but not before the end of the year. In the meantime, those working in the space sector should wait in the faith—particularly if the reserve that Puppi wants remains as it is—that the decision and the relevant political responsibility assumed by Minister Colombo, who has put the ASI under a commissioner, will be a complete success.

European Affairs: Joint EC-CIS Cryogenic Rocket Engine Tests Planned

*BR0311155693 Paris LA LETTRE DU GIEAS
in English 30 Sep 93 pp 1-2*

[Unattributed article: "SEP: Europe-Russia Demonstration Program in Cryogenic Rocket Engines"]

[Text] Combining Russian experience in rocket engines combustion cycles with European expertise in the field of modeling, SEP [European Propulsion Company] (and its European Industrial partners) on one side, and CADB [Bureau for the Design of Chemical Process Control], NPO SATURN, and NIKHIM-MASH (Russian Space Agency) on the other side, have proposed, on SEP's instigation, to ask ESA and CNES [French National Center for Space Studies] to support a demonstration program.

This cooperation involves the testing in Russia of an existing Russian cryogenic engine for which the Europeans will develop a model, based on the test results to be obtained.

This, together with the experience gained and shown on the Vulcain engine, should lead to reliable and predictable means of comparison between the various types of rocket engines.

The purpose of this program is to achieve a better preparation with regard to decisions on future developments of advanced rocket engines that will be necessary for future Space Transportation Systems within the next 30 years, more particularly in the field of reusable systems.

The cryogenic engine selected for this demonstration program is the D57, originally developed and manufactured by LYULKA for the former Soviet Lunar Program. The planned duration of this program is 3 years.

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European Affairs: CIS Technologies To Cut Hermes Cost

BR0311155793 Paris REACHING FOR THE SKIES
in English Sep 93 pp 8-9

[Article by C. Honvault: "Technological Cooperation With Russia"]

[Text] The Hermes programme has had relatively long-standing contacts with Russian space organisations, both at Agency and industrial level. These contacts led to an ESA/USSR agreement on space cooperation in April 1990 and to the establishment of an ESA/Glavkosmos working group on manned space transportation systems. Two sub-groups were set up under this working group, one for the Hermes/MIR mission, the other for cooperation in Hermes-relevant technologies. These existing contacts proved very useful after the ESA Council meeting at ministerial level in Munich, since they offered an organisational framework allowing rapid initiation of discussions on increased cooperation possibilities with appropriate Russian companies and research organisations.

After the Munich Conference in 1991, two meetings were held with the Russians, where the possibilities for cooperation were explored and identified.

These meetings enabled the agency to have discussions through Glavkosmos with representatives of major Russian industrial firms, such as NPO Energiya, NPO Molniya and institutes, TsAGI [Zhukovsky Central Institute for Aerothermodynamics], TsNIIMash. On the industrial side, a delegation from Euro-Hermespace met with representatives of Energiya, NPO Molniya, NPO Zvezda, and the Scientific Research Institute for Technical Glass in February 1992 in Moscow. As a result:

- Dassault, in its role as responsible firm for the thermal protection development and in charge of aerodynamics, was in contact with NPO Molniya for aerodynamical calculations, and with TsAGI and TsNIIMash for wind tunnel tests.
- Dornier, responsible for the Extra-Vehicular Activities (EVA) system, worked together with NPO Zvezda on EVA technology for the Hermes programme. A project for the joint development of a space suit system, called "Suit 2000" has been defined. The studies are co-financed by ESA and the Russian government.
- Fiat Spazio was in close contact with NPO Zvezda for a joint proposal of the ejection seat system for Hermes.

Early in 1992, the Hermes Programme Team worked out a list of about 50 activities suitable for cooperation with Russian institutes and companies which can be grouped as follows:

- Consultancy (e.g., aerodynamics, strategy for materials aerothermal testing, ECLS [equipment control life support], lithium battery).
- Use of facilities (e.g., thermo-mechanical test facility, aero-test facility).
- Purchase (e.g., IVA [intravehicular activity] suits, aeroflight data, crash recorder, thrusters, windshield materials).
- Development support (e.g., landing gear, training aircraft, ejectable seats).
- Joint development (e.g., spacesuits).

This list was discussed and agreed upon at a Moscow meeting of the Hermes Technology Sub-group on 6 and 7 February 1992 and the Russians identified the potential Russian partners for the various contracts.

On the basis of this list, the Hermes programme team prepared procurement proposals which were submitted to the ESA Industrial Policy Committee in March 1992. They cover studies by European companies participating in the Hermes programme and their potential Russian partners, investigating activities which could lead to important savings for the Hermes development programme. The budget of the studies financed by the Hermes development programme was about five MAU (million accounting units) and most of the results were used to support the preparation of the Granada conference in November 1992.

Altogether, 27 contracts have been awarded to Russian firms, either by ESA or by Euro-Hermespace and its subcontractors, plus one to Glavkosmos for the coordination of the work in Russia, for assisting in the interface problems between ESA, European firms, and Russian firms. However, initial difficulties in defining clearly the statements of work and in communication between partners, and the numerous reorientations of the Hermes programme, led to delays in the initiation of the contracts and in the availability of the results: Four activities were completed before the end of 1992 and 25 out of 28 are now completed.

It is worth noting that for each final presentation of the contract results, the European firms interested by the subject have been invited to attend.

From the first results of the studies, it was possible to state in November 1992 that the utilisation of Russian technologies and facilities (test and training) would permit savings of about 15 percent of the total development cost of the Hermes programme by spending 5 percent of the total amount in Russia.

The most interesting and efficient results have been achieved in:

- Utilisation of Russian training facilities instead of building new ones in Europe;
- Utilisation of aeronautical support from LII Gromov for Hermes Approach and Landing Tests (ALT);
- Utilisation of certain test facilities in the field of aerodynamics and reusable thermal protection existing in TsAGI and TsNIIMash;
- Provision of results acquired by NPO Molniya during the BOR4, BOR5 and first Buran flight;
- Testing by ESTEC [European Space Research and Technology Center] of Russian fuel cells.

Following the Ministerial Council in Granada, the initial objectives of cooperation with Russia have been modified and relations have been established between ESA and RKA (Russian Space Agency): Five working groups have been created with the objective of defining possible cooperative activities over the period 1993-1995.

The themes for cooperation in the technological area had been identified by working group STS-2 [Space Transportation Systems]. However, the recent decision taken by the states participating in the Hermes programme to stop the activities concerning winged vehicles leads to a revision of the planned contracts, the budgets of which will be decreased. The list of new themes will be finalised in September 1993.

In general, the contracts which have been placed in Russia have yielded a large amount of valuable information concerning the possible transfer of certain technologies to Western European firms and have led to contacts between European and Russian firms which set the basis for deeper cooperation in the future.

Italy: ARTEMIS Satellite Missions, Program Detailed

*MI2210152693 Rome SPAZIO INFORMAZIONI
in Italian 1 Oct 93 pp 2-3*

[Text] Paris, 1 Oct—A megacontract for the development and construction of the new European telecommunications and data relay satellite ARTEMIS (Advanced Relay and Technology Mission), worth ECU 446 million (amounting to about 825 billion lire), will be assigned to Alenia Spazio by the European Space Agency (ESA) in the next few days. The contract will be signed on Monday, 4 October, in Rome. University and Research Minister Prof. Umberto Colombo, ESA Director General Dr. Jean-Marie Luton, and Alenia Spazio Managing Director Dr. Andrea Pucci, will be present. This is the 10,000th industrial contract to be underwritten by the ESA over the last 20 years. It marks the beginning of a new era of satellite telecommunications in Europe and confirms the leading role that our country has earned in this field.

ARTEMIS Satellite

ARTEMIS will be launched during the summer of 1996 with the second qualifying flight of the new European Ariane-5 carrier. It will be an advanced satellite and will be used to test innovative telecommunications technologies and put them into operation. The satellite will also use new-concept propulsion and attitude control subsystems that will be mounted on its "platform." ARTEMIS is a forerunner of the future European DRS (Data Relay System) system—whose study and definition stage the ESA has also assigned to Alenia Spazio. The DRS will enable ground stations to keep in constant contact with satellites, laboratories, and space stations in low orbits.

The ARTEMIS program provides for three experimental missions in satellite communications: The first is the LLM [Land-Land Mission]. The goal of this mission is to develop and qualify sophisticated technologies and systems for voice and data communication between permanent ground stations and terminals installed on moving vehicles (trains, trucks, etc.) in Europe and in the southern Mediterranean area. The mission should complete the pan-European mobile cellular system in those areas where the cellular system is not able to provide full coverage by 1999. The availability of similar equipment, called the EMS (European Mobile System), aboard the Italian telecommunications satellite Italsat-F2 to be launched during the summer of 1995 that will be in orbit at the same time as ARTEMIS, will assure that the system can become operational before then. The second mission is the SKDR. This will enable experimental and preoperational connections to be made with vehicles that are in low orbits, such as the polar remote sensing platform Envisat-1 and the first elements of the European Space Infrastructure. The primary goal of this mission, which will utilize an antenna with a diameter of about three meters equipped with a direction-finding system developed by Alenia Spazio, will be to verify that this system is suitable for use with new data transmission systems for European and United States consumers. The third mission, SILEX [Semiconductor Laser Intersatellite Link Experiment] is designed to perform optical communications between ARTEMIS in a geostationary orbit, and the French remote sensing satellite SPOT-4 [Probational Earth Observation Satellite], or another satellite that is also located in a low orbit, using laser techniques. The goal of this mission is to verify the validity of the procedures for directing the optical telescopes installed aboard these satellites and also to verify how long the transmitters last in orbit in order to qualify, in space, the technologies that will be able to meet our future requirements for extremely high traffic density reception and transmission of data.

The ARTEMIS satellite will have a total launch mass of about 2.4 tonnes. It will be equipped with an ionic propulsion system together with a new precision sensor to enable better control of the attitude during the propulsion stage. Furthermore, an innovative integrated system for attitude control and data transfer aboard the satellite will be able to supply the necessary operational stability both for the optical communications equipment and for the large mobile antenna.

Netherlands, CIS: Russian Project To Use Dutch Martian Probe

BR0511140193 Rijswijk POLYTECHNISCHE
WEEKBLAD in Dutch 15 Oct 93 p 1

[Article by Gerard van Nifterik: "Drilling for Sediments on Mars: Friesian Soil Probe To Lay Bare Secrets of Mars Within Three Years"]

[Text] Heerenveen—The company A.P. van den Berg BV is probably going to develop a soil testing system for the Russian space industry. Not long ago, the company entered into a technical and scientific collaboration agreement with the Babakin Center in Moscow. If all goes well, within three years a Friesian soil probe will be laying bare the secrets lying under the surface of the planet Mars. According to Eng. A.P. van den Berg, director and founder of the company, this is the result of having been in the forefront of soil probing for one-quarter of a century.

On 20 May 1992, a meeting took place in Moscow which marked the beginning of Heerenveen's space adventure. A.P. van den Berg and colleagues from the renowned Russian Babakin Center, formerly the Lavashkin Institute, concluded a technical and scientific cooperation agreement which has since been officially authorized. Its aim: the development of a soil probe specifically designed for research on and into the surface of the red planet.

The basic technology of the system in which the Russians are now showing so much interest had already been developed in the thirties. At that time, Professor Barentsen from Delft developed the so-called Barentsen cone.

Broadly speaking, the technique consists in inserting a tube containing a rod equipped with a special cone into the ground exerting a particular, measurable force. The resistance at the cone can then be measured, giving an indication of the physical properties of the soil. This simple testing method has provided the basis for a worldwide standardized soil probing technique. The so-called cone penetration test (CPT) was originally known as The Dutch Soil Testing Method.

Automation

Since Barentsen's time much has changed. From a mostly empirical technique, by which only the resistance at the cone and the total adhesive resistance could be measured at intervals of 20 centimeters, it has become an excellent, highly-automated and reproducible scientific technique. Whereas previously it used only two parameters, there is now a whole list: cone point resistance and local adhesion (the relationship between the two gives an exact indication of the nature of the soil, and even of the size of the soil granules); tension of the water; gradient; conductivity; pH; redox; temperature; radioactivity; oxygen content; salt levels; etc. The processing of all this data takes place online, and data can be interpreted immediately, if necessary. In addition, there

is no longer any need for various measurements at intervals, as tests can now be conducted without going through stages. Also, the amount of labor required has been greatly reduced. In the early days, manpower and weight were needed to get a probe into the ground. Since the fifties, this has been achieved by use of hydraulics. As a result, soil testing currently constitutes only a very small proportion of overall building costs, whereas previously it amounted to 5 to 10 percent.

The cone penetration test developed into an advanced technique with a Netherlands ancestor. The inventor of the method, Barentsen, was after all a Dutchman, and if there is one country where, more than anywhere else, the condition of the continually settling ground level causes concern, it is the Netherlands. As a result, it has grown by tradition to be one of the leading CPT countries, and that is one of the reasons why the Russians have now called upon Friesland. According to Van den Berg, his company has for the last 25 years played a leading role in the modernization of probing equipment. That, plus the fact that Van den Berg personally has traveled the world to promote the CPT method with users in remote countries, is yielding fruit.

Russian science is now focusing on distant, exploratory space travel, to Mars, among others. Two missions are planned for 1994 and 1996 during which research will be undertaken into the surface of the red planet. Russia had already developed a system for "deep" Mars surface measurements. It consists of a mushroom-like probe which is parachuted to the surface of Mars and then released from a certain height in order to have it penetrate the surface. Furthermore, the cone is fired off, allowing it to reach a depth of approximately 6 meters. Data are exchanged by means of a connection cable between the cone and the mushroom, and transmitted via an antenna.

"With this method, based on the use of blunt power, few measurements can be made," said Van den Berg, "but this changes if surface penetration occurs more gradually." He therefore showed the Russians the possibilities of the CPT method, which resulted in the current cooperation agreement.

Sediments

At the moment, the Heerenveen engineering office is working on the blueprints for a CPT probing method which has been specifically designed for the pumice-stone-like surface structure expected on Mars. The details are not yet definite, but it is fairly certain that the system will be able to operate on stored energy and solar energy, and that it will probe to a depth of more than six meters, most likely to between 10 and 20 meters. What sensors the probe will contain is not yet known either, but it is not impossible that the greater part of the currently available arsenal of sensors will be used. If traces of water or ice are found deep under the porous Martian surface, the theories that once upon a time water existed on Mars could be proved. Moreover, the system provides the possibility of taking topical samples,

after which fantasy takes over.... "Would it not be marvellous if we found sediments," said Van den Berg. In any case, the system will not be ready for the 1994 mission; the aim is to use it during 1996 Mars project, when the Friesian probe will probably form part of the Mars rover. In the meantime, Van den Berg has opened a branch in Moscow.

AUTOMOTIVE INDUSTRY

Germany: ABB Presents World's Most Efficient Gas Turbine

93WS0729D Duesseldorf VDI NACHRICHTEN
in German 17 Sep 93 p 19

[Article by pit: "World Record in Efficiency"]

[Text]

ABB Introduces New Gas Turbine

"Our new generation of gas turbines has an efficiency 10% better than the best machines of this type in the world," raves Dr. Manfred Simon. He is responsible for the Power Generation Sector of the Board of Directors of the German Asea Brown Boveri AG of Mannheim. The new development of ABB achieves a gross efficiency of 37.8% in solo operation according to company claims. In combined operation with a series-connected steam turbine, the efficiency even reaches 58.5%. If heat is removed for heating purposes in combined power stations, the fuel utilization can be increased to more than 90%.

While the performance improvement of gas turbines in recent years could be measured only in fractions of a percent, the technological breakthrough of the ABB group was achieved by two series-connected combustion chambers. In this process, combustion in the first chamber takes place at a pressure of about 30 bar. Because the turbine inlet temperature was increased only slightly, the ABB development engineers were able to make use of proven materials and tested techniques. Manfred Simon says, "Our customers can consequently expect the same high availability as that of the turbines manufactured by us previously."

The first 165 MW turbine will be delivered by ABB in 1995 to the Jersey Central Power & Light Company in the U.S. state of New Jersey. The contract is valued at 50 million U.S. dollars.

Germany: Daimler Benz' Autonomous Road Vehicle Research Advances

BR0311155093 Edam SUPERCOMPUTER
EUROPEAN WATCH in English Sep 93 pp 9-10

[Unattributed article: "Transputers on the Road"]

[Text] At the World Transputer Conference (WTC) in Aachen (20- 22 September 1993) one of the highlights was an automobile, yes, a self-moving vehicle, i.e., without a (human) driver.

Berta Benz together with her two sons performed the world's first drive with an automobile over a longer distance in August 1888. It took about 100 years for the automobile to evolve to an auto(nomous) mobile. In August 1991 a Daimler Benz autonomous vehicle drove from Stuttgart to Ulm and back, which is a distance of about 130 km. In contrast to the pioneers of the last century, who needed a whole day for a distance of approximately 90 km, this test vehicle drove at speeds up to 80 km/h on the Autobahn [highway]. Meanwhile the algorithms have been improved and enable driving on winding public highways with speeds of over 120 km/h.

Since 1985 Daimler Benz Research has been working on autonomous road vehicles guided by video cameras. In 1989 they decided to use transputers as a development platform for the real-time image processing and control tasks. Since August 1991 their T800-based [transputer] systems are on public roads, gaining experience from more than 2,000 km autonomous driving, including a 600 km trip from Stuttgart to Berlin.

At the WTC conference in Aachen, U. Franke from Daimler Benz AG presented the state of the art of his research group's work on lane keeping, obstacle detection, traffic sign recognition, and development tools for parallelisation. Besides the great challenge of an autonomous vehicle itself, various spin-offs have been derived from the basic techniques that can help the driver in standard as well as critical situations.

With the appearance of the T800 transputer in 1986, parallel computers became available from the open market; Daimler Benz research group switched in 1989 to these processors. This step led to a significant reduction in size and power consumption, so that we were able to fit image processing and vehicle control equipment in the luggage boot of a station wagon, called OSCAR (Optically Steered CAR). So, if you happen to drive through Germany and spot a driverless Mercedes 300 TE car with licence plates S-KU 1432, don't worry (in all other cases, get out of the way and notify the authorities at once).

Real-time image processing for autonomous guided road vehicles makes great demands on the computation power installed in the car. At Daimler-Benz researchers could solve these real-world image processing tasks with a handful of transputers in real time by exploiting available "a priori" knowledge such as predictions for:

- geometric objects and structures to look for;
- dynamic behaviour of (other) cars;
- location of lane markings and traffic signs in the image;
- location of relevant obstacles (in front of the vehicle).

Since finding the different relevant structures are loosely coupled tasks, they can be performed in parallel on different parts of a transputer system. In addition, each

task itself can easily be parallelised on a coarse grain level and thus benefit from the performance scalability of transputers.

Concluding, Franke said that transputers have proved to be a flexible, powerful platform for computer vision on the road. The real-time capability of transputers allowed his group to try new ideas out quickly and hence to learn quickly. With transputers the classic development cycle of 1) testing on workstations with a limited number of images, and 2) subsequent transfer to specialised hardware, is shortened and made more efficient. The road becomes the laboratory.

Although they want to sell cars and thus make money, the final aim of Daimler Benz with this project is not to market autonomous cars, but to increase traffic safety. This is possible if one can develop systems that can detect dangerous situations immediately, and can help/warn the driver. A second goal is to increase the efficiency of (stop and go) traffic. Such spin-offs will begin to appear as add-on car accessories in the coming years. These systems will make driving safer, more convenient, and more efficient.

BIOTECHNOLOGY

Germany: Permanent Controls to Prevent Biological Contamination

937W/S0579B Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 24 Jun 93 p 8

[Unsigned article: "Constant Checking Prevents Contamination. Search for Weak Points in Chain From Producer to Consumer"]

[Text] Frankfurt. The increase in salmonellosis observed by experts with concern since 1986 and its frankly epidemic appearance during the last two years has led to anxiety, speculation and fears and the TÜV Rheinland has organized a forum to investigate the diverse causes. Foods play the dominant role as infection sources. Against the background of an apparently well-functioning hygiene in food handling and a highly modern food and kitchen technology the question arises as to the weak points from producer to consumer. In this connection, in addition to strictly veterinary and human medical problems, a question which stands at the forefront is that of what the food processing industry is undertaking to prevent contamination by salmonellosis. Dr. Ulrich Noehle, quality management director of Nestlé Deutschland AG, Frankfurt, does not see the cause, according to available information, in a corresponding microbiological tainting of processed food, but in its long-known contamination of agricultural products with salmonella, especially eggs and poultry, in connection with the inadequate practice of hygiene by the users of these products. Improvements in hygienic conditions in the manufacture of agricultural products and especially explanations to large and individual users of the

hygienic conditions required for food preparation will lead to distinct improvements, argues Noehle. Otherwise the food processing industry as a producer of prepackaged convenience products is safe from salmonella due to a series of measures, as, for example, through the exclusive use of pasteurized egg products instead of raw eggs, by means of a regular inspection of suppliers, involving a review of the quality safety system (system inspection) and status of hygiene (methods inspection) with all-inclusive instructions to suppliers on improvement in the quality safety system. Essentially a certified analysis of the delivered egg products involves a 100% control, as well as a certification of the analysis of each batch of finished manufactured products and finally, application of Good Manufacturing Practice (GMP) and Good Hygiene Practice (GHP) at each individual enterprise. In order to prevent recontamination the flow of goods "before heating" versus "after heating" is spatially separated. Regular environmental monitoring of the workplace involves attention to the design of buildings and equipment, as, for example, in the manufacture of powdered milk, and finally the regular training of personnel in hygiene matters. Recipe suggestions on ready packaging, in which preparation recommendations are given for eggs, contain important hints for preventing errors in preparation.

German Group Uses Sugar Molecule as Basis for Drugs

93W/S0718B Duesseldorf HANDELSBLATT in German 23 Sep 93 p 28

[Article by Jochen Brinkmann]

[Text]

BIOSYNTHESIS/Research Group Studies Reaction Mechanisms in Nature

Sugar Molecule Suitable as Starting Material for Drug Manufacture Nature is an architect whose designs and intentions we only suspect. For years, scientists throughout the world have tried to understand nature's synthetic pathways and imitate them in the laboratory. At the Technical University in Clausthal, a research group is working on the use of sugar molecules as starting material for drug manufacture, for example, for cancer therapy.

Living cells are capable of producing a bewildering array of organic compounds. In the process, primary metabolites form the stage on which all metabolic processes run their course, they help in energy production or information transmission. Secondary metabolites, on the other hand, are useful for maintaining a living community with other organisms, they scare away predators. For many compounds, science still does not know their

possible functions in the organism. Meanwhile, others are used selectively as drugs, for instance, antibiotics.

Under "Natural" Reaction Conditions

To this day, one riddle of natural substance chemistry is how nature succeeds in synthesizing sometimes very complex compounds. In addition, cells manage with conditions under which science has failed heretofore. While chemists often literally "cooked" their syntheses in the past, or today more frequently work at freezing temperatures of minus 20 to minus 70°C and under pressure or use industrial catalysts, reactions in organisms proceed in an aqueous medium at body temperature.

For several years, research groups—especially in the USA—have been trying to understand these natural synthetic pathways. At the Institute for Organic Chemistry of the TU Clausthal, Dr. Andreas Kirschning's group is working on the biosynthesis of rare carbohydrates which occur as sugar components in a large number of antibiotics. More precisely, it involves 2,6-dideoxyhexoses, like those found in the antineoplastic drug daunomycin.

The goal is to explain via which intermediate steps the rare sugars are synthesized. Presumably nature does not use dideoxyhexoses directly, but rather converts them during the synthetic pathway from glucose until they are combined with the active group of the antibiotic in an activated form—it "builds on" a nucleoside diphosphate. In this form, the enzymes involved can recognize and convert the metabolic products.

Andreas Kirschning: "For chemists, the synthesis of this rare sugar together with the recognition molecule nucleoside diphosphate is still not possible at the present. Therefore we hope to 'outwit' the enzyme by offering it pure dideoxyhexoses and hope that it will also accept this compound and couple to the active group of the antibiotic."

The researchers must still test their hypothesis on the possible intermediate steps of the chemical reaction cascade by labeling the compounds. In this way, they can be found again after their incorporation into larger, more complex compounds. Labeling is carried out by replacing a carbon atom with its ^{13}C isotope, heavier by one neutron, which is a "relative" of the naturally occurring ^{12}C atom, so to speak. If nature actually follows the suspected synthetic path, the labeled components must reappear in the products of biosynthesis.

Whether and how rare sugar compounds can be used for the development of new drugs has been investigated intensively for some years in the USA. Previously, carbohydrates were recognized only as energy stores in metabolism. Today it is known that they perform a wider variety of functions, for instance, communication of cells with each other. Like tentacles, sugar molecules sit on cell walls, proteins, or fats. Viruses or bacteria attach to cells with their aid. This discovery opens up prospects for new therapeutic

methods. If one gives the viruses "dummy" receptor compounds, they may perhaps attack "phantom victims"—the body's cells would thus be protected.

Basic Research the Foundation for Success in Natural Chemistry

Continuing hopes are focused on the development of anti-cancer vaccines with the aid of sugar. However, in order to make this all a reality, it is important to reveal nature's synthetic pathways in the laboratory, to understand them, and perhaps to copy them. In all probability, only enzymatic production will yield the desired active substances. For only these biocatalysts are able to control the configuration of a chemical compound. Only with great effort can the chemist synthesize "left- and right-handed" compounds of the same type separately. The pharmacology is therefore forced to rely on nature's assistance, i.e. enzymes, if it wants to utilize the potential of rare sugars for drugs.

Germany: Computer-Generated Pictures Developed for Clinic Archives

93W50709C Frankfurt/Main FRANKFURTER
ZEITUNG/BLICK DURCH DIE WIRTSCHAFT
in German 1 Sep 93 p. 8

[Article by "JB": "Computerized Picture Transmission in the Hospital. Development of an Electronic Picture Archive/Software for Heart Examination"]

[Text] Frankfurt—Two computer programs that support computerized picture transmission have been developed at the clinic for nuclear medicine at Mainz University. The Gammapiac program involves an image reproduction and processing program for nuclear medicine, computerized tomography and nuclear magnetic resonance tomography images. The program runs on MS-DOS operating-system computers and permits the development of an electronic picture archiving and transmission system.

The personal computers required are already on hand for other tasks, explains Dr. Otmar Nickel of the Mainz clinic (Langenbeckstr. 1, 55101 Mainz). Their main area of application has thus far been predominantly word processing (medical correspondence) and database applications (patient data). The computers' increased power potential now makes them suited also in principle for the computerized analysis of all medically important image data.

In addition to image processing and analysis, computers could also be used for centralized data storage with the capability of access by every hospital station. However, by Nickel's account, a complete internal clinic network of computer systems has thus far become a reality only in a few European clinics. On the other hand, networks are more often available at the department level.

The programs assume that a network of personal computers, a link to the imaging systems, and powerful

software are available. Gammapc enables, among other things, the display of individual images and series of images, the display of sequences of images, and multiple image processing by means of addition and subtraction and multiplication and division techniques.

The second program is called Firstp and is for the examination of heart function. The flow characteristics of the blood in the heart and the heart action can be captured with the help of radionuclides injected into the blood stream and a gamma camera. The gamma camera takes 40 to 50 pictures per second. Then an assessment of the heart's performance is possible by means of the program, it is reported.

Germany: Report on Biosensor Technology Research

93WS0670A Bonn BIOSENSORIK:
FOERDERKONZEPT UND ZWISCHENBILANZ
in German Dec 92 pp 1-7, 9-34, 37

[Selections from BMFT Report "Biosensor Technology:
Funding Program, Provisional Appraisal," Dec 92]

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Preface

The need for a timely and effective changeover to resource-saving and environmentally friendly technologies as well as the central importance of research and development connected with it are increasingly

becoming the focus of public discussion. At the same time there is growing pressure for innovation and competition in the economy.

To support such strategic research programs and technologies for the 21st Century is a central task for the Federal Government's research policy. In this context one of the key roles is assigned to the technological development which uses biological systems, meaning an economy oriented toward natural recycling of materials.

Major steps in innovation and a change of paradigms are today triggered primarily by an interdisciplinary interaction of biological, chemical and physical advanced technologies. Intelligent sensors and control and regulation systems based on them, such as are implemented in living systems, are an important foundation for achieving less use of resources and reduced emissions of harmful substances.

Biosensors are a particularly vivid example of the principle of "learning from nature." Biosensors, being the high-tech probes of the future, enable rapid and highly selective determination and selectivity of biological components.

The BMFT [Federal Ministry for Research and Technology] funds biosensors as a focal point of The Federal Government's Biotechnology 2000 program. The results obtained so far in projects with BMFT project support are encouraging and point the way toward qualitatively improved and at the same time more economical technical problem solutions for health and environmental care, industrial materials processing, food testing or narcotics detection. But they also show that biosensors can be a driving force for interdisciplinary cooperation and an accelerator of innovative structural changes in the economy. In particular, opportunities to renew the economy are opening up for the new laender as well, since there is an outstanding tradition and strong research potential over there in the field of biosensors.

The merger of eastern and western German biosensor research funded by the BMFT has already led to considerable progress. It is important to continue on this path together with our European and other foreign partners and within the framework of international cooperations.

Dr. Heinz Riesenhuber Federal Minister for Research and Technology

What Are Biosensors and What Can They Do?

At first glance nature and technology appear to be an unequal pair. Many people see a contradiction that is almost impossible to bridge between that which is naturally grown and that which is created by human hands. But when analyzing the capabilities which were formed by nature alone in the course of evolution it becomes clear that the animate world makes use of certain "techniques." So, what is more obvious than to build a bridge between animate and inanimate matter?

Living creatures bring about achievements of which technicians hardly dare dream. For example, they react with great sensitivity to many chemical substances. The dog's astonishing sense of smell is well known—the tracking dog's nose is 100,000 times more sensitive than the human one. Eels have the ability to taste even a single drop of a certain compound dissolved in the huge amount of water of Lake Constance. Algae are very sensitive to toxic substances. Butterflies even register a single molecule of their partners' attractant.

By combining the biological components which enable the living things to perceive this with components of measurement and analysis technique, the result is a series of interesting applications to benefit the human and his surrounding world. Biological sensors, so-called biosensors, may be regarded as a bridge between biology and technology (in particular electrical engineering and electronics). They lead to test procedures which can affect the crucial progress in medicine, environmental protection, food technology and food testing as well as in process control in other areas. Even for the nose of the narcotics dog, according to expectations from the most recent research, there is the prospect of an alternative: an artificial detector which reliably indicates the presence of a drug.

When looking at the development of biosensors it is possible to determine that the well-known trend from microelectronics toward increasingly smaller, ever more precise and cheaper equipment is repeating itself. By now, methods originally developed for the production of integrated circuits are being used to manufacture miniaturized sensor electrodes, whose measurements are only a few hundredths of a millimeter. A complete sensor system for diabetics is the size of a fountain pen. Sensor researchers always surprise us with new ideas for the use of biological sensors: Canadian and Japanese companies have brought biosensors onto the market which report the degree of freshness of fish. In industrial process control biosensors are able to monitor precisely the growth of microorganisms, with the help of which drugs can be manufactured. Other sensors can be used to check waste water for toxic chemicals such as polychlorinated biphenyls (PCB), chlorinated hydrocarbons or aromatic compounds.

In all, the following application trends are becoming evident for biosensors:

- Medical diagnostics, including patient monitoring in intensive care and bed-side analysis (directly at the patient's bed)
- Environmental analysis, primarily waste water and water testing
- Food monitoring, for example for purity and freshness
- Process control and substance tests, in the chemical-pharmaceutical industry, among others (for example to replace animal tests)
- drug detection.

These applications are possible because biological sensors are known for their high sensitivity and selectivity, meaning precise recognition of very special chemical compounds, even in the tiniest concentrations. This permits the study of samples with complex composition (such as blood, foodstuffs, air or water samples) without having to prepare them specially beforehand. The analyses can be undertaken faster than before, more reliably and nearly continuously. It is also advantageous that testing and evaluation can be carried out directly at the site of the event instead of in the laboratory. Even today it is possible to foresee a clear reduction of the cost per test to a fraction of the previous expense.

When using biological sensors, the ability of biological materials is utilized to find certain substances, so-called analytes, among a wealth of other materials, according to the key-lock principle of molecular biology, and to react with them. The number of possible analytes (keys) is practically unlimited, as is that of the biological detection materials (locks). As for analytes, they might involve both organic and inorganic substances, such as occur in the living organism and in foodstuffs. In the chemical reaction of the biological material physical parameters—for example the electrical potential, tiny changes in mass, fluorescences or temperature changes—are influenced. The changes are converted into a measurable signal and amplified. Various signal converters can be used for this, according to the nature of the variable to be measured (see Table 1). As a rule, a comparison with a previously reported basic value is used to provide an unambiguous statement about the presence of the analyte.

In this way analyses are possible which were only possible with conventional methods using lengthy separation and test processes, by using animal experiments or even not at all. This palette of advantages is balanced by a disadvantage represented by the often limited stability of the biological sensor.

Table 1: Types of Biosensors

Biological Components	Transducers
Receptor molecules	<i>Electrochemical</i>
Nucleic acids	—potential measurement
Antibodies	—current measurement
Enzymes	—conductivity
Cell organelles	—field effect transistors
Microorganisms	<i>Optical</i>
Plant cells	—photometric
Tissue	—fluorimetric
	luminescence
	<i>Changes in mass</i>
	—piezoelectric
	<i>Temperature change</i>
	—thermistors

Biologische Komponente	Transducer
Rezeptormoleküle Nukleinsäuren Antikörper Enzyme Zellorganellen Mikroorganismen Pflanzenzellen Gewebe	<i>Elektrochemisch:</i> – potentiometrisch – amperometrisch – konduktometrisch – Feldeffekt-Transistoren <i>Optisch:</i> – photometrisch – fluorimetrisch – Lumineszenz <i>Masseänderungen:</i> – piezoelektrisch <i>Temperatureffekte:</i> – Thermistoren

Regardless of whether enzymes, antibodies, nucleic acids, cell organelles, cells or even complete microorganisms are involved—they exist naturally in an aqueous environment. This must be taken into account in developing complete biosensor equipment. As a rule, the biological components are held between membranes (immobilized)—just as in a sandwich. The analytes can diffuse from the sample through one of the membranes and react with the biological components. The signal thus produced is transformed and transmitted by the signal converter. These processes of detection—signal conversion—and signal processing take place in the smallest space.

In order to bring the biosensor in its three-part construction to functional maturity, it is necessary to have close, interdisciplinary cooperation. The wealth of variants of possible biosensors (according to the type of biological detection material, the type of analyte or the type of signal converter) shows a close interlinking of molecular biological, biochemical and physical-technical work.

Biosensors—Motors of Interdisciplinary Cooperation

The combination of biological molecules with electronic signalling requires broad cooperation by scientists and technicians to a particular extent. Biosensor technology is thus a crystallization germ and a motor for interdisciplinary cooperation. A biosensor test device has several parents: On the one hand it requires biologists and on the other engineers from measurement and control technology; it needs the expert knowledge of analytical chemists, semiconductor and microsystem specialists, biochemists and materials researchers.

One example of the broad dialog is the Biosensor Working Group, which was created in Duesseldorf in 1989 by the Science Center of North Rhine-Westphalia. Research laboratory results from the whole FRG are discussed here as well as medium and long-range prospects for biosensor technology. Domestic developments

play just as large a role as European and worldwide progress in this modern technology. The working group also offers a suitable basis for the flow of information between science, economy, research funding, and administration. Joint research and development projects bridge various scientific cultures between the participating fields. The development and application of biosensors produces indispensable stimuli. The Biosensor Working Group meets semiannually for two days of symposia.

In order to promote contacts between science and economy, the Biosensor Working Group publishes an address book which provides information about the fields of activity and area focal points for biosensor researchers and is updated twice a year.

Biosensors—Focal Point of Biotechnology Funding

Biosensor technology is a focal point for the Biotechnology 2000 funding program, which was agreed on by the Federal Government in 1990. The goal of this program is to keep Germany attractive as a site for research and production and to continue to improve the framework conditions for implementing research results in the economy. It can already be foreseen that biotechnology will strongly influence the innovation cycles of the 21st Century—just as microelectronics have done today.

Analyses, tests, and monitoring of biological and chemical processes occupy a key role not only in biotechnology. In many fields exact information about the composition of media as far as the smallest concentrations is urgently necessary. More and more precise measurement methods are called for. When it involves reporting on the composition of body fluids, for example, or determining the quality of water or proving contamination or toxins in foods, biosensors are gaining increasing importance as test systems.

The Starting Point

At the end of the 1980s, newly developed electrodes had paved the way for miniaturized biological sensors; they

competed increasingly with conventional analytical technology. The world market for biosensors was estimated at 50 million dollars annually—the one for analytical equipment amounted to the many times greater sum of about 20 billion dollars. It was anticipated that a rapid development of biosensor technology would take place in large sectors of the analytical field and that it would dominate.

At this time the FRG threatened to lose its link with this innovative field of technology: With respect to the number of publications and patents the FRG ranked only in sixth place behind clearly leading Japan and the almost equally ranked countries of the United States, Great Britain, GDR, and USSR. The then GDR was ready to bring out the first, nearly market-ready products. Technically, the design and application of enzyme electrodes was of primary importance—a line of research which in subsequent years has been pursued with the development of microelectrodes and so-called enzyme-field effect-transistors (FETs).

The Biosensor Funding Plan

As a result of talks given by experts on the subject of bioelectronics in the year 1985, of a bioelectronics workshop in 1986 and of the biosensor workshop in 1987, in the summer of 1988 the BMFT established a special funding area called Biosensors. The focal points for this subject was the development of biosensors into process control, monitoring of food quality and application in the environmental sector. The following research policy goals were established with the Biosensor funding plan:

- Progress in the field of government research on prevention in health and environmental protection
- increase in the competitiveness of the economy
- strengthening of research performance through interdisciplinary cooperation.

The Biosensor Funding Plan—A Motor for Innovative Structural Changes in the Economy

Biosensors and the control and regulation systems based on them are an important foundation for the development of resource-saving and environmentally compatible production methods (such as better efficiency, lower resource consumption and reduced pollutant emission). By way of industrial process technology, biosensor research opens up new fields of activity and market positions for the economy on the way toward more economical and qualitatively improved technical problem solutions or drug detection.

The innovative structural change connected with the undertaking and implementation of such research projects in the economy was and is being supported by the BMFT's funding of biosensor technology.

Since the beginning of the funding measure (1988) the BMFT has spent about 40 million German marks [DM] (including the already appropriated funds for the subsequent years) on biosensor projects. About half of the amount for these support measures, whose practical

implementation in part extend far into the future, was also mobilized from the private sector. On the one hand, these funds are used to advance pioneering scientific research (direct project support), and on the other hand the BMFT intends to stimulate primarily small and medium-sized enterprises to implement the results of the research (indirect-specific support for small and medium-sized enterprises). Since 1991 the BMFT has set aside about DM 4 million for biosensor projects specifically for these companies. Productivity and interdisciplinary cooperation have been given a lasting impetus.

In all, the financial participation of the business economy in biosensor funding projects has constantly increased. While initially the bulk of the funding went to new objectives in pioneering research on the scientific side, right now (1992) 19 out of a total of 33 BMFT funding projects are being worked on by the business economy.

An Interim Appraisal

The BMFT's support for the institutional area and with project funds helped biosensor research and development in Germany to achieve a lasting upswing. To begin with it was necessary to stimulate the scientific process as well as interdisciplinary processing of new types of fields needed for implementation in business. Tying in with this, involving a growing share of the science and business sectors, jointly supported projects were developed with the participation, on the scientific side, of both university and extra-university institutions (large research establishments such as the Society for Biotechnology Research in Brunswick or the Max-Delbrueck Center in Berlin-Buch, Max-Planck Society, Fraunhofer Society) and, on the part of the business sector, small and medium-sized as well as large enterprises.

German biosensor research experienced new impulses from being integrated, after the German unification in October 1990, with the groups once active in the former GDR in this field. The well developed biosensor research and development over there was included and strengthened by the BMFT support activities as an opportunity to rebuild the economy. Thus, at present 15 of the 33 funding projects (as of 1992) are being carried out in the new laender, 12 of them within the framework of the private economy. The sponsoring of projects at research institutions and enterprises in the new laender is of special significance, since it could trigger important impulses for the revitalization of the economy.

The integration of the western and eastern biosensor research supported through BMFT subsidy projects has already led to recognizable progress. An actual analysis (1992) of publications and patents shows that Germany has now moved up to world leadership in this field.

Positive structural changes occurred in the economy on the upswing of this development, particularly based on close ties between research and industry: A growing number (at present a total of nine) of small and medium-sized enterprises, among them also a series of newly

founded ones, are devoting themselves to such research and development work. This trend is continuing. The following chapter provides information on the most important funding areas which were and are being pursued within the range of biosensors.

Areas of Biosensor Funding

The spectrum of subject areas supported by the BMFT is broad. It is determined by current international research orientations, the innovation level of the funded projects, the potential application fields and the anticipated markets.

It has also been possible to take an initial, promising step within the framework of European cooperation between science and the economy. An enterprise in the Dresden region is participating with British and Italian partners in a EUREKA project for developing new, highly sensitive biosensors for medical diagnostics. This is the first EUREKA project in the field of biotechnology in the new laender.

In all, within the scope of the funding plan the BMFT has funded 51 projects in the following five subject areas:

Medicine

In the field of medical application, the research is concentrated on equipment for on-line monitoring of patients, as well as clinical diagnostics. In on-line monitoring continuous sampling and analysis is undertaken or direct measurement in the body. These faster methods are of particular importance in surgery and when used in intensive care.

New problem solutions are possible in important care sectors which can deliver improved and, in addition, economical diagnostics in medicine. Here sensors are in demand both for analysis of body matter as well as to detect medicines and drugs (among them doping tests), for example in the blood and urine.

One of the supported projects deals with the treatment of persons with diabetes illnesses. Here it is above all precise information about the current glucose status (sugar content in the blood) of the patient that is needed. This makes it possible to add the required amount of insulin to the organism at any time and to control the treatment effects, which assures an approximately normal glucose metabolism in sick persons and thereby largely eliminates the stress of side effects. An implantable glucose sensor, that is to say one that is inserted into the body, coupled with an insulin pump, will meet these requirements in the future. Functions and properties of implantable sensors are determined primarily by the fact that essential measures common in conventional analytics (such as dilution of the sample, separating components, washing the equipment) are not possible in the body. Furthermore, such sensors must be biocompatible (tolerated by the body) and be able to be sterilized (made germ-free). Finally, they must be extremely small and demonstrate great and lasting reliability, because the sensor can no longer be calibrated after the implantation.

With the present routine methods (laboratory analyses or test strips for self-checking) such continuous monitoring of the metabolism is neither possible nor acceptable due to the cost and the burden on the patient. But extensive additional research is needed until an application of implantable sensors is possible in humans.

Another example is the development of a new type of pocket lactic acid meter, which is characterized by simple handling and rapid measuring. Lactic acid (lactate) occurs during the breakdown of glucose in the body when not enough oxygen is present. Knowing the lactate concentration makes it possible to obtain an objective evaluation of the stress on the body, for example in intensive, industrial, or sports medicine. When the body is overloaded, there is an accumulation of lactate. This is noticeable for instance as a so-called charley horse after excessively high stress on the body. The presently used methods to measure this are too clumsy and do not permit rapid reaction to changes in the body's condition. Information about the degree of stress on the heart can be vital during heart operations, for example. A modern device with an integrated biosensor will deliver such information. In addition to applications in the operating theater and in industrial or sports medicine, the results of this project are also of importance in emergency diagnostics.

The projects to develop an implantable glucose sensor and a pocket lactate meter are joint projects by research establishments and small and medium-sized companies in the new laender. A pocket lactate and a pocket glucose meter will be on the market in 1993. The cost for a single measurement based on biosensors can be reduced to one-tenth of the cost of conventional analyses by means of test strips. Furthermore, physician and laboratory personnel costs are saved by the ambulant handling.

Drug Detection

Drug detection plays a significant role in the battle against abuse of drugs and narcotics. A convenient and reliable test device can replace the drug-sniffing dog, which is expensive to use and also not possible everywhere. This opens up prospects for more effective combating of organized crime and drug abuse with their consequences for the individual and for society.

Research establishments in the old and new laender are therefore working together with industry on developing a test unit for mobile application. Since the concentration of the substances to be detected in the air is very low, the sensor system must display very high sensitivity. This means that it must find a single drug molecule among 10 billion molecules of air. Furthermore, this unit must be convenient and easy to use. The production costs of the sensor should stay within reasonable limits, so that broader application is possible (customs and police stations); the measuring time must lie within the sensible range (for example, below one minute for checking persons and luggage). In addition, a low error rate of less than one percent is necessary. As biological components in biosensors one uses specific antibodies to the analytes.

to be detected which guarantee precise recognition of them. A series of new techniques will still have to be developed and improved for this. More than most, this project requires close cooperation between science and industry. Work on it was begun in 1992 and will continue for the next few years.

Food Testing

The veterinarian, agricultural and food sectors are other application fields for biosensor technology where the BMFT's funding is at work. In the last few years people's awareness of healthy food and thus the demands for purity and excellence in high-quality foods has increased. Biosensors are applicable in order to detect alcohols, lactic acid, glutamine or urea in selected foods as well as to report foreign substances of all kinds (such as pesticides, toxins, foreign hormones). Work is increasingly being done on sensors that permit the determination of complex properties such as freshness and aroma. The actual test process is very complicated, particularly when using multielectrodes (for simultaneous determination of several analytes or properties) and requires highly developed evaluation electronics. As a sensor it is primarily so-called ion-selective microelectrodes and current-measuring enzyme electrodes which are being used. Another variant of the lactate detection unit mentioned above could, for example, find broad application not only in medicine but also in studying the degree of freshness of various foods or in quality control of production and product testing of meat and dairy products.

Work with optical immunosensors is under way to determine mycotoxins (mold toxins) in foods. Here fiberglass sensors are used. Antibodies to the poisons to be detected are applied to them. Before the actual measurement the fibers are coated with fluorescent toxins, which in contact with the sample are exchanged

with non-fluorescent toxins if any are present. Differences in the fluorescent behavior on the surface of the fiber are used for the measurement. Simple handling and yet high sensitivity are the goals for the work.

Environmental Protection

In the fields of environmental protection and safety in the workplace biosensors to measure pollution as well as analyze ground, air and water samples have major application potential. The BMFT's funding program of small and medium-sized companies enabled two companies jointly to take up the development of a test system for waste water analysis based on a microbial sensor. A device to check waste water was thus built, which can replace the conventional, days-long laboratory procedure with field measurements and even on-line measurements. With this unit, which uses a biosensor, the results are available after three to five minutes, and this is on location (for example in the treatment plant) and at significantly lower cost.

The basic idea for the sensor that tests the biochemical oxygen demand (the BOD value), which is a measure of the degree of pollution, was to imitate the processes in a settling basin in the unit. This is in order to stay close to the actually occurring processes in the analysis. To this end microorganisms which occur in sewage sludge are tested for their applicability as biocomponents in the equipment. The selected organisms are affixed to a membrane. There they are nourished by the organic components of the water samples. The amount of oxygen then used allows conclusions to be drawn about the degree of pollution in the water.

In the equipment the biomembrane is stretched in front of an oxygen electrode. The electrode records the oxygen content of the waste water sample and its reduction when passing the biomembrane. Comparison measurements

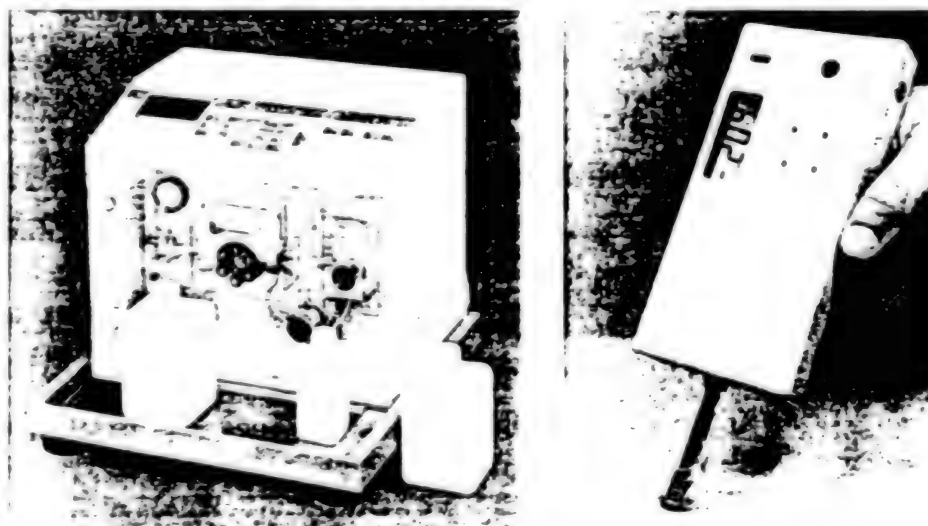


Fig. 8: Biosensors for Use in Environmental Analysis

Left: Equipment for rapid determination of biochemical oxygen demand (Photo: PGW Prüfgeräetewerk Medingen). Right: Prototype of a one-way biosensor hand-held measuring unit for on-site analysis of phenols (Photo: Environmental Research Center Leipzig-Halle).

before and after passing the membrane makes it possible to determine the oxygen consumption. The first units are now being offered to municipal waste water treatment plants for testing under practical conditions.

According to the same principle, additional test opportunities are to be studied in the food industry, in bioprocess control in general and in other industrial processes with biotechnological steps.

Process Control

In industrial process control, measurement, control and regulation and the monitoring of production sites is indispensable. In particular for biotechnological methods, such as cell culture technique of human or animal cells and in the production of antibiotics, process control is of considerable importance, since, for example, instabilities during the course of the process could destroy the production of several days. Improved knowledge of the concentration processes of conductive substances in the fermenter is vital for optimal process control. Therefore the applicable media and nutrients are to be efficiently utilized, so that the smallest possible space and a high degree of utilization of the desired product can be achieved in a short time. For the majority of the nutrients, such as carbohydrates, amino-acids as well as for low-molecular products (penicillin, citric acid, gluconic acid, lysine, glutamic acid) proven enzyme electrodes already exist. They permit the determination of the analytes on line and while preserving the sterility of the biotechnological reaction space.

For simultaneous measurement of various process variables, multicomponent sensors are being studied on the basis of bio-field-effect transistors (BioFETs). Using these it is possible to measure substrate and product concentrations continuously in bioprocesses. Various series-connected BioFETs with varying enzymes can be used for this. In order to determine substances with high molecular weight, such as pharmaceutically interesting proteins from cell culture technology, automated immune analyzers are being developed. Rapidly working systems for on-line coupling to bioreactors are being prepared in close contact with industrial users. The first systems for determining selected substances in cultivation processes are in existence.

There are two fundamentally different approaches for further developments: On the one hand the need to develop specific sensors or sensor systems for additional analytes. On the other, automatic measurement systems must be constructed which permit sterile sample-taking as well as transportation of the sample to the specific sensor. Several projects have now been approved in this field. The grant recipients belong to various establishments (higher academic institutions, Max-Planck and Fraunhofer institutes, institutionally supported facilities as well as industry) in the FRG.

Outlook

In the long term biosensors, in addition to "classical" physical-chemical test instruments, will become an

indispensable sensor technology for numerous applications, since it can combine the following advantages:

- High sensitivity
- brief measuring time
- considerable reduction of the costs of testing and analysis
- flexibly designed procedural steps, depending on demand
- possible computer-networked operation in specifically designed equipment versions
- application in automated measurement and regulation systems.

An important research objective for the future are multiparameter sensors or combinations of biosensors with tiny manipulators (micropumps, microseparating systems, etc.). But numerous questions and problems must still be solved. Among them are the short life of the biocomponents, the long manufacturing time, insufficient knowledge about molecular-biological processes, frequently still lacking biocompatibility and the difficulty for implantable sensors to keep the system sterile. This has the result that the development of competitive products versus the conventional analytical technology until now has usually failed due to the lack of routine stability of the biosensor device. Further, there is a remaining hurdle for the electronics and microsystem technology industry in producing equipment which works with biological material. Because of the initial interdisciplinary research effort, in all areas of biosensor technology the cooperation supported by the BMFT by scientists and engineers in the fields of molecular biology, biochemistry, chemistry, physics, materials sciences, semiconductor electronics and technology as well as information science is of extraordinary importance for the success.

Biosensors—a Research Field for New Technologies of the 21st Century

What is the future for biosensor technology in Germany? Many topics are being worked on in this field in the research laboratories. Medium- and longer-range research tasks have been initiated; they end in three to four years.

Rational and economical assessment of complex matters in all the application fields mentioned is becoming increasingly important in terms of the economy and from a general social aspect. For this task biosensors have attracted particular interest in past years from scientists and technicians. Through the biological reagents in combination with physical-chemical transducers, specific identification in complicated mixtures are possible without the customary use of chemicals otherwise employed in analytics and without environmentally harmful waste products.

Based on the most highly developed biosensors with classical electrochemical transducers, for which there is still a considerable production and handling demand, two principal directions are emerging for further development: One is characterized by the integration of biological sensor components into microsystem technology. The other direction is more marked by the biological components in the sense of new biomolecular function systems for technology.

Accordingly, in further researching the biocomponents the biosensor technology expects to receive significant impulses from genetic and immune technology for highly specific and reactive compounds. Principles of biology, which so far have only been rudimentally applied, such as for biochemical amplification of signals, are intended to make ultrasensitive biosensors possible. One so far unattained model for this is the million-fold signal amplification in blood coagulation: According to the snowball principle, single signal molecules activate a few enzyme molecules, and they in turn dozens of others and so on, until finally the "avalanche" of the last phase causes the wound to close.

New technologies such as bioelectronics can find application here. The development of highly integrated, electronic components, which are based on biological structures and principles, so-called biochips, must be included in this. There are already some attempts to design biochips for biosensors. Biological switches, diodes, triodes, transistors and even processors are among the components of the biochip. In this connection biomolecular computers and machines are also being discussed. Triodes, in which an electron flow is controlled by the presence of certain ions and it is thus possible to achieve amplification, are known in principle and in some prototypes. Among them are the biological ion-sensitive field effect transistor. Principles of neurobiology and neuro-information science will play a crucial role in developing a biochip (information transmission, storage and processing). Techniques for localizing biocomponents in the chip, immobilization of entire components on natural or synthetic membranes as well as biocompatible encapsulation have so far only been very incompletely developed, however.

The progress of miniaturization and advanced integration appears to make it possible to build so-called sensor arrays. With that is meant an arrangement of a large number of sensors in the smallest space. They can be used to record complex properties in a specific manner. Conclusions regarding concentration gradients and dynamic properties are also possible, meaning for the high-resolution, chronological course of processes. It is understandable that for such complicated arrangements, where a great deal of data and information accumulate at the same time, a powerful computer technology (parallel computer) is indispensable for the evaluation.

Substantial leaps in innovation are also anticipated from integration of biosensor components into complex microsystems, in which the focus of the research and

development work will be on the field of microsystem technology, the technology of tiny miniature pumps, valves, lasers, measuring systems and manipulators. The application potential for such high-technology systems is extremely broad and ranges from implantable artificial organs (such as an artificial pancreas for diabetics) to on-line systems in industrial process technology. In each case the goal is to develop the corresponding combinations of methods and processes in micromechanics, microelectronics and biotechnology.

The trend toward miniaturization of biosensors is endless, not only in this context but in general. Miniaturized biosensors can be coupled with the powerful and efficient methods of microelectronics in large production numbers and technologically in a relatively simple way with a biocomponent. The problem with such hybrid systems, in which biological and nonbiological components are coupled, is the specific attachment of the biocomponents and the coupling of signal transmitters. Even today work is under way on totally new concepts, in which electrons wander directly from an analyte by way of the biomolecule and tiny electrical conductors—molecular wires, so to speak—and trigger the measurement signal. Here the starting points for close interlinking with nanotechnology, another key technology for the 21st Century, can be found. The next step would be the combination of biomolecules, sensor structure, actors and evaluation electronics in a single chip. Miniaturization and mass production should similarly reduce material consumption and individual price, as is the case in electronics. To achieve further miniaturization a lesson can also be learned from biology: For its components it makes do with dimensions which are yet another factor of 10^3 to 10^6 smaller than the electronic components common today.

At present biosensors have been described for about 120 different parameters, meaning analytes. Among them are sensors for low-molecular substances (metabolic products, pharmacologicals, nutrients, gases, heavy metal ions), sensors for enzyme components (active groups, vitamins, coenzymes, polymer hydrocarbons as well as starch and cellulose), for viruses and for microorganisms. The majority of these developments are still at the stage of solution in principle, however.

Regardless of which path toward market-ready product is taken, no one who wants to be successful in the international analysis and test equipment market can avoid biosensors. The range of predictions from market researchers is quite large. While some studies assume a turnover of several billion dollars a year, the Swiss market research company Prognos forecasts a sales volume of 920 million dollars for 1995.

Due to the already achieved market shares and the initiated research projects, German companies are now in a favorable starting position in the international competition. Efficient laboratory analyzers with biosensors were developed in Dresden. New kinds of mini-analyzers for decentralized measurement of blood sugar

and lactic acid are being put on the market by Magdeburg and Berlin. For waste water monitoring a modern biosensor test device from Berlin is available. Ultrasensitive sensor systems for narcotics detection are under development in Munich.

Based on already successful biosensor applications in the health and environmental protection areas, in food monitoring and industrial process technology, a multitude of new application possibilities are likely in the future in nearly all scientific and technical fields. Leaps of innovation can be anticipated primarily in measurement and analysis technology, since this is where biosensors can supply the key to completely new problem-solving attempts. Intelligent control and regulation systems based on this are an important contribution on the way toward resource-saving and environmentally compatible technologies, so that biosensor technology will advance to become an important technology in the 21st Century in many fields.

Sensor Systems—Incentives for the Economy

In the future customer-specific sensor systems will also gain importance as mass products. Specialization and flexible reaction to customer demands makes it possible, particularly for small and medium-sized companies, to enter this promising market. Improving the competitive situation for these enterprises is the task for the non-profit Institute for Chemo and Biosensor Technology (ICB) founded in 1991 in Muenster, administered by the Fraunhofer Management Society. The ICB has already developed various sensor systems (ground water monitor, adrenaline sensor, multi-ion card, microsensor in silicon technology, potentiometric immune sensor) for mass markets and exhibited them at trade shows. Some of these developments are now being brought to the production stage in cooperation with industry, supported by funding from the BMFT, the European Community, and the working group of industrial research associations.

SUPPLEMENT

A list of current BMFT funding projects (as of 1992):

Messerschmitt-Boelkow-Blohm GmbH, Munich: "Drug Detection Equipment Based on Biosensors"

Boehringer Mannheim GmbH: "Drug Detection Equipment Based on Biosensors"

Max Delbrueck Center for Molecular Medicine, Berlin: "Drug Detection Equipment Based on Biosensors"

Technical College, Koethen: "Development of Methods and Constructive Solutions for Coupling Test Systems to the Process"

University of Hanover: "Development and Application of Biosensors in Biotechnology"

Technical University of Hamburg-Harburg: "Fiberoptic Biosensors for On-Line and Continuous Off-Line Operation"

B. Braun Melsungen AG: "Biosensors for Fermentation Control"

Eberhard Karls University, Tuebingen: "Sensor Systems Based on Receptors"

Technical University, Munich: "Integrated Membrane Solid State Systems and Their Application in Bio- and Chemosensor Technology"

Technical University, Munich: "Development of Biosensors for Substrates of Oxido-Reductase Through Coupling of Coenzymes and Redox-Active Mediators to Conducting Polymers, Semiconductors and Metals"

Oxyphen GmbH, Dresden: "Development and Optimization of a Substrate-Limiting Membrane for Biosensors"

Ludwig Maximilians University, Munich: "Electrochemical Hybrid Biosensors"

FZB Biotechnik GmbH, Berlin: "Enzyme Membranes for Process Control Through Enzyme Electrodes"

Technical University, Munich: "Development of Flow-Injection Systems Based on Biosensors to Regulate and Optimize Processes in Food Production and Processing"

Westphalian Wilhelms University, Muenster: "Biosensor Developments Oriented Toward Methods, Equipment and Applications in Environmental, Food and Biochemical Analysis"

Pruefgeraetewerk Medingen (PGW): "Development and Optimization of Biosensors and Adaption to New Laboratory Analyzers"

EKF Industrie-Elektronik GmbH, Magdeburg: "Development of Intelligent Biosensors for Lactate and Glucose Measurement"

Bio Sensor Technologie GmbH, Berlin-Buch: "Development of Modified Enzyme Membranes for Lactate and Glucose-Enzyme Sensors"

Elbau Elektronik Bauelemente GmbH, Berlin: "Development of New Types of Cylindrical and Planar Oxygen Measurement Electrodes for Use in Biosensors"

Institute for Diabetes Technology, Karlsburg: "Continuous Subcutaneous Measurement of Tissue Glucose Using Microdialysis Technique as a Prerequisite for Feedback Insulin Infusion (Portable Artificial Pancreas)"

Joint Project of University of Greifswald/Oxyphen GmbH Dresden/EKF Industrie-Elektronik Magdeburg/Elbau Elektronik Bauelemente GmbH Berlin: "Intracorporeally Insertable Biosensor for Glucose"

Pruefgeraetewerk Medingen GmbH (PGW): EUREKA Project "Applications of Biosensors in Ultrasensitive Immunoassays"

Max Delbrueck Center for Molecular Medicine, Berlin: EUREKA Project "Functional Principles of Ultrasensitive Enzyme Immunosensors for Diagnostically Important Proteins"

Max Planck Society For Promotion of Sciences, Munich: "Biosensors for Oxygen Pressure, PCO₂/PH and Glucose Based on Specialized Cells of the Glomus Caroticum, the Brain and the Vessels"

University of Hamburg: "Miniaturized Immuno-Flowthrough Sensors"

Fraunhofer Society E.V., Munich: "Joint Research Project on Biosensors for Water Monitoring"

Messerschmitt-Boelkow-Blohm GmbH, Munich: "Biosensors for Water Monitoring"

Draegerwerk AG Luebeck: "Immunosensors for the Gas Phase"

PGW Medingen/Aucoteam GmbH Berlin cooperation: "Microbial Sensors for Equipment for Process Monitoring and BOD Determination"

Medizin- und Labortechnik Engineering GmbH, Dresden: "Development of a Flow Injection Analyzer With Biosensor and/or Bioreactors for Environmental Analysis"

Dr. Bruno Lange GmbH, Berlin: "BOD Sensor"

IFZ—Biotechnologische Forschungs- und Entwicklungsgesellschaft GmbH, Berlin: "Development of Microbial Sensors for Environmental Monitoring"

Joint project between Technical University of Magdeburg/Sensortech GmbH/Environmental Technology Society/Buna AG: "Mass-Sensitive Sensors for Environmental and Process Analysis"

Recommended Literature:

"Biosensors: Fundamentals, Technologies and Applications" published by F. Scheller, R.D. Schmid, VCH Verlagsgesellschaft, 1991.

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"Annual Report 1991" to conclude the Biotechnology 2000 Program, project sponsor Biology, Energy, Ecology of the BMFT, Juelich Research Center, Technical Information Center Karlsruhe, 1992.

"Biosensors," SPEKTRUM DER WISSENSCHAFT, September 1992.

PHOTO CAPTIONS [photos not included]

1. Fig. 1: Principle of function of biosensors: According to the so-called key-lock principle, the biological sensor ("lock") reacts to a specific substance to be analyzed, the analyte ("key"). The physical parameters which change as a result of the reaction are converted, amplified and indicated by the signal converter (transducer) into measurable signals. (Graphic: UNIVERS/Max Ley)

2. Fig. 2: Application fields for biosensors: Biological sensors can primarily be used in four major areas, since in appropriate versions they are able to fulfill the most varied analytic tasks. In the future a special application field for biosensors will be in fighting drug abuse—a sensor for drug detection is right now under joint development by science and industry.

3. Fig. 3: Applications for biosensor research within the framework of the Biotechnology 2000 program: as of 1992 (in addition about DM 20 million were raised from the private economy).

4. Fig. 4: Centers for biosensor research and development in Germany.

5. Fig. 5: Analytical equipment for medicine. Left: Medical catheter sensor (enlargement). The tube with the sensor at the tip can be inserted into a central venous heart catheter for blood pressure measurement. The black dot at the tip of the tube represents the actual sensor. It is 0.5 by 0.5 mm in size. (Photo: ICB/Medispo). Right: Biosensor for measurement of glucose in medicine and biotechnology. (Photo: Institute for Technical Chemistry of Hanover University)

6. Fig. 6: Analytical equipment for medicine: Pocket measuring device for lactate determination. (Photo: EKF-Industrieelektronik Magdeburg).

7. Fig. 7: Water sensor in practical application. (Photo: AUCOTEAM Berlin).

8. Fig. 9: Diagram of further development toward the integrated, miniaturized biosensor, the "biochip."

9. Fig. 10: Potentiometric multi-analyte sensor with integrated signal processing. This biosensor can be used in various application fields, since membranes for various analytes can be applied to the five little silver discs (Photo: ASTEC/IBC).

Germany: Biotechnology R&D in New Laender Summarized

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FORSCHUNG UND PRAXIS in German
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[Article by Wilfried Wascher and Cordula Tegen, Federal Ministry of Research and Technology Biology, Energy, and Ecology (BEO) project managers: "Results and Prospects of Biotechnology Funding in Eastern Germany"—first paragraph is BIOENGINEERING FORSCHUNG UND PRAXIS introduction]

[Excerpts] Prior to unification, the former GDR was home to a number of highly reputed biotechnology research teams. As a move to counter the disintegration of worthwhile capabilities due to distortions in the political and economic situation and the subsequent fundamental social transformation, the BMFT [Federal Ministry of Research and Technology] opened up its funding measures to eastern German scientists even before the two states had achieved full unity. The rapid integration of research teams into current joint projects, the establishment of groups of trainee researchers, the support provided for partnership projects in neurobiology, grants awarded for industrial projects under the "Upturn East" program, and funding for small and medium-sized biotechnology enterprises [SME's] have been and remain measures that are exerting a lasting influence on the creation of a pan-German biotechnology research scene. Restructuring industrial research requires investment on the part of industry and the collaboration of universities and of non-university and industry-oriented research facilities. This will make it possible to take effective advantage of the boost provided by BMFT funding.

One of the BMFT's special schemes is designed to improve the chances of eastern German trainee scientists who want to go into biotechnology: 22 million German marks [DM] are being provided over five years (1992 to 1996) in the form of grants to 11 trainee groups in the new federal laender. The intention is to enhance the competitiveness and attractiveness of the scientific facilities there and reduce the risk of a further brain drain. The emphasis lies with topics presenting high innovative potential, such as the clarification of the structure and function of genome information, protein engineering, and the development of new technical applications for molecular and cytobiology. Posts have thus been created for 28 scientists, 11 postgraduate students, and 11 scientific assistants.

Neurobiology research is one of the disciplines in which advanced research was performed in the former GDR. The BMFT is funding nine east-west neurobiology partnership projects with about DM8 million over three years as a means of expanding cooperation between east and west German research teams. This both contributes to the creation of a unified German research scene and makes it possible to speed up the fitting out of east

German research laboratories with world-standard apparatus. These projects aim to achieve a better understanding of the processes that take place at molecular level during learning, the interaction between nerve cells and the cells surrounding them, nerve cell development, and the restoration of their functions after partial destruction. The intention behind the grants awarded under the "Upturn East" program is to contribute towards the creation of new economic structures in east German biotechnology. East German enterprises received grants worth over DM23 million for research project in 1991 and 1992. This bridging support makes it easier for research companies or associations, many of which are offshoots of the research and development departments of former state-owned enterprises, to gain a foothold in the market economy; it has been granted to 18, mostly small and medium-sized, facilities. Overall, mindful of the fact that a particularly strong boost to the economy is expected to come from this branch of science and technology, the BMFT invested almost 30 percent of the funds allocated to it under the "Upturn East" program in biotechnology. This notwithstanding, considering the industrial research capability that used to be available in the former GDR, the BMFT's funding is undoubtedly having only a limited effect. There is a need here for action on the part of the Federal Trade Ministry and the land-level trade ministries, which is being met with various measures that we cannot describe more fully here. In view of the critical situation facing east German industrial research, the fact that BMFT "Upturn East" funding measures have the privatization of eight biotechnology facilities to their credit must be seen as a positive result that will make a lasting improvement in the structure of east German industry and research.

The BMFT's SME biotechnology program is also enhancing the economic structure. The first pan-German SME funding program, announced on 1 July 1991, was very well received in the new laender. About half the five-year program's overall budget of DM100 million has been allocated to date. Of the 120 approved research and development projects, 40 (accounting for DM10 million) are being undertaken in the new laender. Approximately 1 million marks more are going to east German participants in the form of subcontracts from west German firms. The continuing bias embodied in this funding measure becomes clear when one considers that the new federal laender contributed only seven percent to the gross national product of the Federal Republic in 1992 but, taking subcontracts into account, received close on a quarter of the SME biotechnology program funds. The goals pursued under this SME program are as follows:

- (a) To step up preliminary research for health-care and environmental purposes.
- (b) To tap the economic potential of biotechnology.

The projects cover a very wide range of topics, from the elaboration of genetic engineering methods and research

into natural matter, through animal breeding-related research and biological reclamation processes, to novel measuring systems and biosensors. With regard to biosensors, it is worth pointing out that the new laender are giving a particularly innovatory thrust; indeed, it is no coincidence that the first east German EUREKA [European Research Coordination Agency] project is being undertaken in biotechnology, in Medingen, Saxony.

The BMFT also has responsibility for building up and maintaining non-university research capabilities, in which connection the Max Delbrueck Center in Berlin-Buch, the Environmental Research Center in Leipzig/Halle, the Institute of Molecular Biotechnology in Jena, the Institute of Plant Genetics and Crop Plant Research in Gatersleben, the Institute of Plant Biochemistry in Halle, and the Institute of Neurobiology in Magdeburg may be cited; support is being granted to the Hans Knoell Institute of Natural Matter Research in Jena in the form of BMFT project funding.

East German biotechnology also benefits from state support for newly established firms, from technology and entrepreneur centers, and other indirect measures such as research and development staff recruitment subsidies. Now that the aforementioned measures have been launched and implemented, it is deemed necessary to return in the near future to direct project funding by the BMFT as the main channel of funding. One of the goals is to integrate innovative R&D teams from the laender of Brandenburg, Mecklenburg-Western Pomerania, Saxony-Anhalt, Saxony, Thuringia, and Berlin into existing joint projects or to establish new, wherever possible industrial, joint projects in which eastern Germany will play a major role.

State funding has got a number of research facilities and teams in eastern Germany off to a good start, but the state cannot solve every problem. For instance, industrial research in eastern Germany can only be revitalized if industrial companies too commit themselves to a higher level of investment, if new, technology-oriented SME's spring up in large numbers, and if advanced joint research—involving the universities, non-university research facilities, and industry-oriented research—creates new high-tech centers.

Netherlands: University Runs Biotech Technology Transfer Centers

BR0511103693 Rijswijk BIONIEUWS in Dutch
9 Oct 93 p 1

[Unattributed article: "Groningen Biotechnology Heavily Subsidized"]

[Text] Groningen University's biotechnology institute, the GBB (Groningen Biomolecular Sciences and Biotechnology Institute) is doing well from the financial point of view. The last few weeks, it received several million guilders in subsidies. Among other things, the institute intends to use this money to set up two profit centers which will be of service to industry.

The GBB is receiving 2.5 million Dutch guilders in subsidies for the new centers within the scope of the Economic Affairs Ministry's Integral Structure Plan for the North of the Country (ISP-4). The university will provide the basic facilities, at a cost of about 3.5 million guilders. The remaining 1 million will come out of the proceeds from the profit centers.

One of the new centers will be involved in protein engineering, and the other with cell engineering. The chairman of the GBB board, Professor Dr. Gerard Venema, expects the research to be conducted at the profit centers to lead to new patents, which the institute can then sell on to industry. He is thinking here particularly of the dairy industry and starch manufacturer AVB. Venema is very confident about the future of the centers: "Within five years they will self-sufficient."

Last week the GBB became officially recognized as a research school. It will form part of an association of Netherlands research schools involved in biotechnology, which has received 15 million guilders from the Ministry of Economic Affairs to be used as stimulation funds.

In addition, the European Commission has designated the GBB as a host for the Human Capital and Mobility Program. It is to be allowed to take on five foreign post-doctoral students for a period of two years.

Germany: Biotechnology R&D at Niederurseler Hang Described

MI610111793 Frankfurt/Main FORSCHUNG
FRANKFURT in German No 3, 1993 p 33

[Article by Heinz Rueterjans of Frankfurt University: "Joint Research"]

[Text] The Land of Hesse has a research center growing up on the Niederurseler Hang [hillside], where the structure and function of biological macromolecules are being researched. The focus is not merely on basic principles, but is primarily on developing new pharmacological substances. The three-dimensional structure of proteins is first studied using methods such as X-ray structure analysis and nuclear resonance spectroscopy, after which their interactions with membranes, nucleic acids, and other biologically active molecules can be addressed. A computer is used to model these molecules and their dynamics with a view to designing new biocatalysts.

The Niederurseler Hang Biocenter brings together teams of physicists, chemists, biologists, and pharmacologists. Several teams from [Frankfurt University] departments 15 (biochemistry, pharmacology, and food chemistry), 16 (biology), and 19 (human medicine) are already working together on special research project 169, studying the structure and function of membrane-bound proteins. Special research projects are long-term German Research Society schemes, generally running for 12 to 15 years, under which scientists work together on interdisciplinary research programs.

Many teams complement one another in an ideal manner at this center. For instance, Prof. Christian Griesinger's team from the Institute of Organic Chemistry is working on new nuclear resonance spectroscopy methods, while Prof. Heinz Rueterjans of the Institute of Biophysical Chemistry focuses on applications. Other teams, such as those headed by Prof. Lutz Nover of the Institute of Botany and Prof. Theo Dingermann of the Institute of Pharmaceutical Biology, are using the molecular biology methods of genetic engineering to extract greater quantities of the various proteins. In this way, several institutes work together on joint projects, both under special research projects 169 (Membrane-Bound Proteins) and 269 (Molecular and Cellular Bases for Neural Organization Processes) and on the land-funded "Muscarinic Agonists and Antagonists" program. The individual teams are already receiving considerable funding from the German research Society, the Federal Ministry of Research and Technology, the Land of Hesse, and industry.

The Niederurseler Hang Biocenter has instituted a new undergraduate course in biochemistry alongside those training students in chemistry, biology, pharmacology, and food chemistry. Interest in the course has proved so great that, as in pharmacology, biology, and food chemistry, numbers have had to be restricted owing to limited capacity.

Two graduate courses have been set up in the Faculty of Biochemistry, Pharmacology, and Food Chemistry with German research Society funding to enable postgraduate students to prepare their doctoral theses within a purpose-designed curriculum. They thus work in a comprehensive research context organized by the university professors concerned. The graduate course on the structure, dynamics, and function of proteins makes postgraduate students familiar with the methods of protein research, while the course on "pharmaceutical products that work from the nervous system as an example of drug development" teaches them to isolate natural substances, synthesize and analyze biocatalysts, and undertake pharmacological research into pharmaceutical products that work from the nerve cells. The Department of Chemistry runs a graduate course on the chemical and biological synthesis of biocatalysts. The Niederurseler Hang is thus becoming a not insignificant center of biochemical and pharmacological training at the teaching level as well.

COMPUTERS

Germany: Computer Reacts to Human Gestures

93W50709A Frankfurt/Main FRANKFURTER
ZEITUNG/BLICK DURCH DIE WIRTSCHAFT
in German 30 Aug 93 p 10

[Article by "re": "Computer Reacts to Gestures Too"]

[Text] Frankfurt—Siemens researchers have succeeded in utilizing human gestures in order to control

machines and computers. Now objects are supposed to be able to be shifted and turned on the screen by means of simple hand movements. Other instruction sequences could also be initiated in this manner, reports Siemens AG [German Stock Corporation] of Munich and Berlin. The technique has considerable advantages over control devices like the mouse, spaceball, dial boxes and dataglove.

The recognition of gestures takes place in two steps. First, the computer works out from a picture taken by a video camera the hand's outline and its orientation in space. In a second step the computer classifies by means of rules the kind of gesture. Here it distinguishes, for example, whether the hand is forming a fist, the index finger is extended, or whether the thumb is pointing toward the right or left. Specific meanings can be assigned to gestures once they are recognized.

As Siemens points out further, the system has to have high processing speed in order to work efficiently with hand gestures. There should be no more than a tenth of a second between gestures and a reaction on the screen. Moreover, processing power of the order of magnitude of a freeze frame rate of 25 frames per second is called for in order for the sequence of actions to be smooth. This is already achievable on personal computers of the 486 and Pentium class with suitably designed software, they say.

The recognition of gestures has shown itself to be reliable also under difficult limiting conditions like a nonuniform background and varied lighting situations. High accuracy is being achieved, they say, by a combination of absolute position indication and fine adjustment in interactive communication with the user.

France: Cray C 98 to Be Inaugurated in Toulouse

93W50730E Paris LF FIGARO in French
24 Sep 93 p 14

[Article by Jean-Paul Croize: "New Brain for Weather Service"; Subhead: "Cray C 98, Inaugurated This Morning in Toulouse, to Keep Better Weather Eye Peeled"]

[Text] This morning in Toulouse, at Meteo-France's headquarters, a new "Cray" family "super-computer" that is four times as powerful as its predecessor currently in use, is going to be inaugurated by Meteo-France's general director, Andre Lebeau. The Cray C 98 will be the most powerful computer ever installed in France. With a price tag approaching 100 million French francs [FF], that machine should improve the country's weather services' forecasting capabilities because of Arpege, the French weather service's future software for computing the movement of air masses.

Having this kind of power and computational speed¹ will enable integrating many more localized meteorological phenomena into the parameters used for preparing forecasts. Enough to satisfy three primary objectives: the most spectacular will be to steadily refine the geographic

accuracy of short-term forecasts of less than 24 hours, by providing them with much more precise timing for a given location. The arrival of an area of rainfall in the day, presently announced with an hourly precision on the scale of a single region, could be announced on level of a department.

Next, it will be possible to extend beyond the present five-day limit forecasts involving global weather development while retaining a level of reliability that will remain "operational." Lastly, such a computer will make it possible to noticeably improve the effectiveness of computational models that simulate atmospheric movements on a global scale.

Reality and Fiction

Ever since the period of the first digital forecasts, already 30 years ago, Météo-France has managed to quadruple its computational power every five years. Each time a new computer and its accompanying software were put into operational service they were practically linked with the definition of the follow-on system. The concern always has been to narrow the size of the computational matrix filtering the changes in the atmosphere. Realizing that each doubling of the sensitivity of the matrix requires 16 times more computational power, the principle's limits can be conjured up. Computer power is not enough, ever greater speed in performing the operations is also required, lest the reality of atmospheric change be seen ultimately overtaking the fiction of the forecasts projected by the computer.

The Cray 2 currently operated by Météo-France's central service take as much as six hours to project an atmospheric grid and derive from it a semi-hemispheric forecast. Beginning 18 October of this year, it will be possible to "break in" the Arpege computational model. But only after the Cray C98, installed in Toulouse, is "broken in," theoretically toward the end of the year, will that new forecasting software be dumped onto it. It will then be able to unleash its full power as the world's first forecasting system equipped with variable dimension computational matrixes.

Météo-France is therefore operating two distinct systems for the time being. One, christened Emeraude, covers the entire globe with a matrix that is several hundred kilometers wide. The other, named Peridot, covers France and the areas around it with a much tighter web, each of whose threads is approximately 35 km apart. Arpege's development required several years of work by the scientists from the organization and from the National Center for Scientific Research [CNRS]. With its variable dimension matrix design it will afford the possibility of "zooming" at will over one or more points of the world when preparing a forecast.

By closing the matrixes to points about 30 kilometers apart over France, it will replace Peridot, starting 18 October, and, by the same token, it will eliminate the

occasionally irritating computational glitches occurring along the edges of the seam joining the broader-matrix Emeraude system.

Footnotes

1. The Cray 98's total computational power allows it to process four billion operations per second with an architecture based on the parallel installation of four processors operating simultaneously. Its storage capacity, in turn, amounts to 160 billion data items in main memory and 320 billion data items in back-up memory. In its final configuration it will be able to have twice as many capabilities. It will then reach a transfer rate of nearly 80 billion data items per second.

Germany: Applications of Fuzzy Logic, Neural Networks Combined

93WS0710A Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT
in German 6 Sep 93 p 10

[Article by "sel": "Fuzzy Logic and Neural Networks Combined in New Applications. Aachen MIT GmbH [Limited Liability Company] Wants to Control Complex Production Processes Better With Neuro-Fuzzy Systems"]

[Text] Aachen—The Aachen MIT GmbH company expects that fuzzy systems and neural networks combined could lead to new applications in the future. Thus far both lines of research have developed quite independently of one another, but this could change before long. At present such "neuro-fuzzy" applications are being studied only in scientific circles. Therefore bringing these lines together is also not a very simple thing, because thus far there are only researchers who are knowledgeable about only one of these two fields.

A few consumer-good products are being offered already under the neuro-fuzzy logo only in Japan. They include a fan from Sanyo, a vacuum cleaner, a washing machine and an air conditioner from Panasonic. There has been no special neuro-fuzzy hardware thus far, because either purely fuzzy or purely "neuro" hardware seems to have been sufficient for processes critical with respect to time.

Neuro-fuzzy systems can be put together in various ways by using two basic approaches. The first approach is to have a fuzzy system's knowledge base learned or optimized, as the case may be, by a neural network. Here the form of the association functions and the operators employed can be already predefined, and just their parameters need to be determined by means of the neural network. With the second approach the neural network is designed so that each neuron layer can be assigned the processing steps of one fuzzy system.

The cost of the development of a neuro-fuzzy system is greater than that of purely fuzzy design approaches, because, besides the way of defining the rule base, it is necessary to choose appropriate network structures.

which almost always has to be done by a procedure of the "trial and error" type. Thus, the addition of a neural component to fuzzy systems presents itself with large fuzzy rule bases. The benefit for neural networks is that in this case they yield intermediate products in the form of association functions intelligible to humans.

Dr. Richard Weber and graduate mathematician Karl Lieven of Management Intelligenter Technologien GmbH [Smart Technologies Management, Ltd.] (MIT, Promenade 6, 52076 Aachen, tel.: 0 24 08/9 45 80) think that the fuzzy hardware's level can be of interest primarily for the execution part of the network, while neuro-hardware is necessary mostly for the learning part, which can run to a few days. Moreover, practical application rarely requires special hardware. It is only the acquisition of special hardware for development of the neural or fuzzy system that is necessary then. Neuro-hardware development products fall under "high-end" applications and are rarely suited for the mass market, they say.

MIT in Aachen is a company independent of software and hardware manufacturers that develops custom computer programs for the solution of complex problems. The company is developing a program for data analysis in the form of the "DataEngine". In addition to neuro-fuzzy designs, the techniques necessary for the analysis of data are also being used for this purpose, for processing and statistical analysis. Both the latest scientific techniques and traditional approaches to analysis are being included in the DataEngine, they say.

MIT GmbH is under the scientific direction of Dr. Hans-Juergen Zimmermann, a professor at Aachen Technical College, and was founded in 1991 jointly with the European ELITE foundation. New methods in the field of fuzzy control and fuzzy data analysis and for assisting in decision making, in the field of power plants, for example, are being developed in numerous international projects like ESPRIT and BRITE-EURAM.

The emphasis of the work is presently the development and implementation of fuzzy control design approaches, and the development and implementation of classification diagnosis and process identification systems based on fuzzy data analysis techniques and fuzzy-neural networks. Finally, the company's work schedule also includes the development of complex production control systems for process engineering, manufacturing technology and assembly technology processes employing fuzzy Petri net approaches.

Germany: CAD/CAM System Aids Textile Industry

93WS0710C Frankfurt/Main FRANKFURTER
ZEITUNG/BLICK DURCH DIE WIRTSCHAFT
in German 8 Sep 93 p 8

[Article by "Scha": "Optimized Processes to Help Make the Clothing Industry More Efficient. Data Integration in Companies Is Being Expanded/Relocation Abroad Is Lowering Interest in Research"]

[Text] Frankfurt—The German textile industry, as ever, is facing the pressure of having to use the latest technology in order to remain competitive. Productivity and flexibility requirements are growing more and more. On this account, a greater multiplicity of designs with smaller quantities per design and ever shorter life spans are necessitating an increased need for management tools for material, product and information flow. A prerequisite for sound company decisions is up-to-date information for quantity, time and capacity scheduling and for manufacturing.

CAD/CAM systems are already routine in clothing industry companies. But many companies use them just for digitizing, grading and position displaying, while pattern design and making the prototype of the pattern are still being done predominantly by hand. In a few cases the description of the design is already being developed with the aid of a computer, where design data files, drawing data files and surface-material and accessory data are stored in a database.

CAPP [computer-aided process planning], CAM and MRP [material requirements planning] systems are increasingly becoming established in the area of work scheduling. System houses are trying more and more to integrate in a common network the areas of sales order processing, planning and scheduling, purchasing, production control, time scheduling and manufacturing resources planning, surface-material and accessories store and shipping control, billing, costing, time management and bookkeeping, all by means of CAx systems. Drawing plotters, automatic folding machines and NC cutting machines are being controlled off line or on line. Cutters and folding lines are linked with one another through network database systems. Pattern data are being automatically converted to control data. The most up-to-date ISDN communications technology is expected for external communication—company with company, with suppliers and with the trading sector—for the international clothing industry machine show from 21 to 25 September 1993 in Cologne. For instance, the several-weeks-long coordination time from pattern design, material development and finishing—dyeing, for example—can be shortened decisively, as far as graphics are concerned, by means of video communication.

Networking is of special importance, and the trend toward data compatibility must be retarded no longer. Satisfactory data systems technology integration is being achieved by means of open-system networks (Open System Local Area Networks, abbreviated OSLANs), whose interfaces bring about total compatibility. For instance, Ethernet and token rings have been generally adopted for communication in networks. Data systems that are expandable at will and enable branching without limit through a subject field continue to spread.

It is precisely in databases that a trend can be traced in the direction of system-optimized access to more powerful database systems that, for one thing, have already made their appearance in EDP, and, for another, can be

used in the overall corporate structure through SQLs [structured query languages] or SQL servers. Conventional databases are being replaced by relational. There are already also databases (especially in the area of CAD) expansions of which have been added in the multi-media direction, so that completely database-assisted product development is being made possible.

Greater user friendliness is the focus for industry-segment software. According to an analysis by Association Ingenieurs Conseils AG [Consulting Engineers Partners, Inc.] (AICO) in Zurich, there is a second trend in the direction of low-cost systems and low-price entry, i.e., entry with a clearly defined cost-performance ratio, without watering down the move toward the major CAD-solution.

Creative solutions for the relocation of production to the new countries of the East and the third world to which work is being farmed out are also emerging. For instance, the now ready-to-market project of body-type-oriented designing on the screen, the professional program for designing on the screen with macros, or synoptic real-time planning are taking their place in supplementary special software.

CAM peripherals include plotters and every electronically controlled or CNC cutting medium. They are all tied to presupposed CAD. Here the trend is toward the improvement of data flow and data quality in order to mobilize reserve capacities. Approximately the same state of the art exists among the major suppliers of blade-supported cutters. A new development for the equal-selva folding of several plies for cutting to size by means of CAD-dependent cutting equipment featuring endless feeding is a typical case. A low-ply cutter whose blade oscillates at the rate of 10,000 times per minute has been put on the market as a new development for this purpose.

In the opinion of industry experts, hydrocutters will not be generally accepted in the clothing industry, but they probably will for upholstered furniture for cutting to size heavy two-dimensional sheets. Laser cutters are also suited only for heavy material. They are being used in the needlework industry for the manufacture of industrial material. A laser with conveyor-supported loading and waste disposal is a new thing here.

The Forschungsgemeinschaft Bekleidungsindustrie eV [Clothing Industry Research Association Registered Association] in Cologne characterizes as regrettable the relocation of manufacturing capacities to ever more distant areas of the world, because interest in further development and new development is dwindling for this reason. In order to place research at the disposal of the entire industry, joint research with the cooperation of industrial partners is important, they say, because research means an advantage and future security for companies.

Germany: Dedicated Software Developed to Improve Rationalization

93WS0710D Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 8 Sep 93 pp 1, 8

[Article by Ulrich Dietz: "Rationalization Can Be Improved By Software. Harmonize Programs With Organizational Aspects"]

[Text] St. Georgen—The safeguarding of competitive advantages now appears to be the central goal of many companies. In addition, market advantages are to be gotten increasingly only by the employment of new technologies. For this reason companies should change their data processing systems in time in order to avoid loss of productivity. This thesis is supported by extensive polls and analyses of German companies carried out by GFT (Gesellschaft für Technologietransfer [Society for Technology Transfer]) in St. Georgen, taking into account data collected by the Dataquest, Diebold and IDC market research institutes. If one extracts from the results of the study, a substantial share of the rationalization potential of German trade and industry lies in computer software. However, a prerequisite for this is the proper and carefully directed use of dedicated software and harmonization of the computer software with organizational aspects.

Using GFT's analysis, one finds that German companies and authorities in 1992 spent around 11.5 billion German marks [DM] for the purchasing of software. This represents an increase of approximately 12 percent as compared with the year before. A further increase by approximately nine percent to DM12.5 billion is anticipated for this year. Although this appears to be quite innovative, around 60 percent of these expenditures represent misdirected capital spending, because the respective software is not useful for rationalizing or improving productivity. The programs' poor suitability for the respective specific problems to be solved and the misplaced use of the software must be declared the main reasons for this.

Furthermore, one was able to ascertain that with approximately one third of all software purchases existing unproductive processes are being further entrenched in the companies and organizations, so that, at high cost, the obstacles in the way of rationalization are being increased instead of reduced. The misplaced use of computer software is having disastrous consequences particularly in the area of administration. A decline in productivity of by six percent per year on average can be noted in German offices since the middle of the eighties, i.e., since the arrival of personal computers and workstations. The reason for this certainly lies not in the computers but in the software.

New Technologies Require New Working Methods Too; Standard Software Can Also Result in Loss of Productivity/System Integration Utilized Too Little

There is often such a gap between the company's organizational structures and the structures of the software used that the personnel have to devise tricks to outsmart the programs in order to get their jobs done. Many companies and authorities have had to pay dearly with loss of productivity in practice for their course of action of buying relatively inexpensive standard software without carrying out appropriate organizational measures. Those who believe that increased productivity in the area of administration can be gotten just by equipping workplaces with personal computers and groupware are very much mistaken.

The rationalization and productivity potential can be exploited fully through business re-engineering, for example. By this is meant the harmonization of organizational and technological aspects with a view toward maximum competitiveness in the market. New technologies like client/server data processing, object-oriented software, multimedia or mobile-radio data transmission are opening up substantial potential, provided that they are integrated organizationally into working methods.

Before the introduction of new technologies, then, a thorough check should be made of to what extent existing methods are still efficient in view of the new capabilities. Organizational changes are necessary in over 80 percent of all cases in order to derive proportionate benefit from the jumps in technology. If these changes do not take place, the benefit is uncertain or can even turn into the opposite. If several steps backward of this kind occur over the years, there will be the productivity decline mentioned, of six percent per year on average.

The harmonization of computer software with organizational aspects calls for concentrated system integration going far beyond the mere adaptation of standard software on the basis of a few parameters. However, the utilization of system integration has been poor thus far, contrary to the reports in the media.

For instance, according to GFT's investigation, German users spent around DM1 billion for system integration in 1992. This is less than 10 percent of the expenditures for the purchase of standard software, according to the report. The market researchers put the market volume of custom software developed for solving customers' problems at around DM4.5 billion for 1992.

Unfortunately this trend will become even stronger because of the price drops that are beginning for standard software, as favorable as this may seem at first glance. One has to worry that because of this still more companies and authorities will offer their personnel standard ready-made packages without adapting them and integrating them organizationally.

The effects on productivity will be proportionately catastrophic. A nearly straight drop in prices for DOS and Windows standard software can be observed since 1991, and this will continue this year and next. The price drop for Unix-based software is expected to begin at the end of the year.

Companies and authorities can only be strongly advised not to base their decisions on the purchase cost of hardware and software, but to make the productivity benefit for their organization the basis for acting.

Germany: Fuzzy Technologies for Artificial Intelligence, Expert Systems Discussed

93WS0729B Duesseldorf VDI NACHRICHTEN
in German 17 Sep 93 p 1

[Article by Jens D. Billerbeck: "The Need for Information on Fuzzy Technology is Great"]

[Text]

First European Conference for Fuzzy and Intelligent Technologies

A study, produced by the Fuzzy Initiative of North Rhine-Westphalia, sees a variety of possible applications for fuzzy technology. These are primarily in the areas of measurement, open-loop and closed-loop control systems, and optimization. The study is based on a poll of companies in North Rhine-Westphalia. In the study, about 70% of the companies were familiar with fuzzy technology but many criticized the fact that they did not have sufficient information to provide a final evaluation of this technology.

However, this is not the only obstacle to practical conversion of fuzzy technology. The study listed a lack of methodical procedures and, in some areas, the lack of appropriate tools and inadequately illuminated economic aspects of fuzzy technologies as additional hurdles.

And these obstacles are considerable. In contrast to other studies, the Fuzzy Initiative of North Rhine-Westphalia did not express any opinions on future market developments. However, it did cite other studies that at least give an impression of the dimensions to be expected. A market report of the German Chamber of Commerce and Industry on Japan estimates the worldwide market for fuzzy systems and components at about 500 million Deutsche marks in 1995 and 5 billion Deutsche marks in 2000. For fuzzy application systems in the area of artificial intelligence and expert systems, it will be 12 billion Deutsche marks in 1995 and 36 billion Deutsche marks at the turn of the millennium. In the opinion of the market research company Prognos, about 400 million dollars will be spent in Germany in 1995 for fuzzy logic controls. Five years later, this will already be 2.3 billion dollars.

Fuzzy technology is based on a mathematical theory developed by Lofti A. Zadeh in the 60s at the university

at Berkeley. If, in classical logic, the statement "The element A is a member of the set B" is either true or false, fuzzy logic allows a weight to be assigned to the membership of an element to a set. Building on this, a technology was developed which, for example, makes it possible to describe measurement and control processes with rules using everyday language.

However, the potential of fuzzy technology is not exhausted in pure control technology. This was made clear at the First European Conference for Fuzzy and Intelligent Technologies, Eufit. This conference was held last week in Aachen and had more than 500 participants. The director of the organizing committee, Karl Lieven from MIT GmbH of Aachen, emphasized the significance of fuzzy technology to the VDI NACHRICHTEN. In this respect, he views the most interesting and most future-oriented applications over the long term to be in pattern recognition and data analysis.

The lively participation at the conference proves that fuzzy technology has been accepted to a large extent in the meanwhile. In spite of this, there are pockets of resistance. On this topic, the study by the Fuzzy Initiative says, "The arguments of the opponents to fuzzy technology must be taken seriously. Many of these are based on misunderstandings that can easily be explained. An all too frivolous defense of the fuzzy technology point of view toward other technologies must be avoided."

Germany: High-Performance Computing Funding Judged 'Inefficient'

BR031156-3 Edam SUPERCOMPUTER
EUR 031156-3 WATCH in English Sep 93 pp 6-7

[Text] Secretary of State G. Konow from the Science Ministry of the Northrhine-Westphalia Government welcomed the participants of the WTC 93 [World Transputer Congress] on behalf of his minister (who apparently couldn't come). After pointing out—as expected—that Aachen was an important centre for science and technology, not only in Germany but also in Europe, he turned out to be unusually well-informed. His underlings might have told him details like that this year the transputer has become 10 years old, but you don't get vision from last minute briefings.

The transputer was produced by the ESPRIT [European Strategic Program for Research into Information Technologies] project SuperNode. In 1989 the EC established this technology at European universities by launching the Parallel Computing Action. This certainly was a successful step, explained Konow, but it is now by far too small and remained academic. "The following year much time was wasted until the Rubbia Report vaguely indicated how to proceed further in HPCN [high-performance computing and networking]. In the meantime the American, and Japanese programmes have been launched with generous funding, either in the name of

national security or to secure and improve economic competitiveness," he analysed.

He observed that the political/economic scenery has been changing the last few years in Germany. Since unification, Germany must cope with the heritage of the first Arbeiter und Bauerstaat [workers' and farmers' state]—"it will take us at least 10 years to cope with it." Unfortunately the West German economy is, just now, experiencing its worst economic crisis since 1945. "Nothing happens, except for the loss of 12,000 industrial working places per month in the state of North Rhine Westphalia alone, once the industrial heart of Germany," he noticed bitterly. Even bigger problems are growing in Germany's backyard.

To cope with economic problems, modern technology and HPCN is indispensable. And, yes, only a few weeks earlier, the German Federal Government had announced its high-performance computing initiative: "A program coming too late, and with ECU 10 million per annum, totally inefficient." Konow rode his hobby horse vigorously: 10 million Ecu are the equivalent of the cost of one km of highway and the Germans are constructing hundreds of kilometres of it every year, "destroying what is left of their environment, without really improving traffic conditions."

The future of MPPs [massively parallel processors] based on European technology thus fully depends on the realisation of the Fourth Framework Programme of the EC. Konow concluded. He expected a budget of ECU 400-500 million from that source [Framework Program] for HPCN. The programme will have an overall user-orientation and will stress industrial applications, but Konow predicted that the promotion of basic research will in the long run be even more important. "So a joint action of the EC and the leading industrial member states in this field seems to be necessary."

The transputer, said Konow, has been the first and most prominent parallel processor worldwide. The importance of parallel processing has been established in Europe and is currently recognised in the United States and Japan. Many experts maintain that the transputer chip is the last domain in the information technology field where Europe still has a key position. "I don't know how long this leading position will last. I think we have two options in the field of high-tech R&D. Either we place ourselves under nature preservation or we try harder." He welcomed that the conference program showed that, the speakers at least, obviously voted for the "try harder" approach.

Italy: Research Center Focuses on Supercomputing

MI1410123493 Turin MEDIA DUEMILA in Italian
Sep 93 p 87

[Text] Rome—ENEA [National Agency for New Technologies, Energy, and the Environment] has embarked upon a major supercomputing project, i.e., a project

relating to supercomputers performing 100 billion operations per second, both as a user to allow research to make a big step forward and to collaborate in the development of software and applications and thus secure itself a leading role in the sector on a world basis. Nicola Cabibbo, its president, presented the project by explaining that it was the outcome of agreements with Alenia Spazio (Finmeccanica [Mechanical Engineering Finance Corporation]), which produces the highly advanced Quadrics supercomputers, and with the National Institute of Nuclear Physics (INFN) whose "Ape" supercomputer produced by its own researchers is at the very basis of the development of these commercial computers, currently the most rapid in the world (100 billion operations per second with a target of 1 trillion in a few years).

INFN President Luciano Maiani and Alenia Spazio General Codirector Antonio Rodota also took part in the presentation of the project. The first step will involve the acquisition by ENEA of five Quadrics supercomputers for less than 10 billion lire to develop "virtual laboratories" to be used to simulate phenomena that cannot be studied in detail with field research only: e.g. global climate model, nuclear fusion, land, and ocean analysis via satellite. This is what Alenia Spazio, which produces remote sensing satellites, is aiming at according to Rodota.

Cabibbo stated that ENEA will satisfy the organization's tasks in full and will provide the national production world with the knowledge, methods, and infrastructures needed to use the supercomputer in manufacturing processes (even in the manufacture of saucepans and taps) and to introduce the high-speed computing elements in the very products that are becoming increasingly "intelligent" in all fields. Cabibbo explained that programs in the environmental field that make use supercomputers range from climate models, urban areas, and a map of the whole Mediterranean area.

Research and transfer of knowledge to industries will be followed by the third phase of the ENEA supercomputing project. This will involve collaboration in the development of Quadrics supercomputers and associated programs for the world market. In Europe, declared Pistella, there are no other computers of this level and there are only two or three producers in the rest of the world. Since these computers are designed for specific applications in the most varied sectors, emphasis will have to be put on the development of application programs "that must solve users' problems" and that, together with the computing speed, will act as a driving force for the collaboration between the three organizations. NNNN

Italy: Olivetti Opens R&D, Training Center

MI2510140793 Milan *ITALIA OGGI* in Italian
13 Oct 93 p 12

[Article by Eduardo Cagnazzi: "Olivetti Opens New Technology Center in Pozzuoli"]

[Text] Jobs for 1,500 young people, 80 percent of whom are university graduates, are to be provided by CTSI (Company Services and Technical Center), the new science and technology pole set up by Olivetti in Pozzuoli under an agreement with the Aracnopolis consortium, CISI [International Company for Data Processing Services], Formez, the Federico II University, and the science and technology park of the city of Naples. Local businessmen and their engineering companies are also to take part.

The projects that will be developed there concern artificial intelligence, expert systems, multimedia integration, and the development of systems capable of designing computer software. These areas of research, which are part of the Olivetti center's activities, have been implemented after the signing of an agreement with the government.

The technology center has great ambitions: To become an authentic incubator of minds for research, development, and experiments. Nonetheless the Pozzuoli center will also place considerable emphasis on training. The first computer engineering faculty is to be opened there, creating a long-awaited link between industry and educational establishments for training highly qualified personnel.

By focusing on the formation of a network of connections between the bases where the major scientific brains in the EC operate and on a sophisticated technology capable of transmitting a wealth of documents as well as audio and video data simultaneously to several places via a fiber-optic system, the strategic growth plan for the CTSI aims directly at the European market

A number of applications are foreseen, primarily for improving the efficiency of the public administration. Thanks to telematics, for example, lasers will shortly be used in the health sector for reading clinical records.

DEFENSE

France: Franco-British Group To Develop New Airborne Radar System

AU1810142693 Paris *AFP* in English 1348 GMT
18 Oct 93

[Text] Paris, Oct 18 (AFP)—A Franco-British electronics grouping has been awarded a contract to develop the next generation of airborne radar systems for fighter planes, the French electronics company Thomson CSF announced on Monday.

A research and development contract for 270 million franc (47.4 million dollars) was issued jointly by the French General Delegation for Armament and Britain's Defence Research Agency, Thomson said.

Governments will contribute 60 percent of the funding, with private industry providing the rest, according to Thomson.

The research will serve as the framework for developing a European "active antenna" radar system to be placed on future fighter aircraft, the French electronics firm said.

GEC Thomson Airborne Radar, or GTAR, was formed in 1991 by Thomson CSF and the British company GEC Marconi.

S&T: BAe, Matra Considering Joint Missile-Building Company

*AT 2610094093 Paris AFP in English
0921 GMT 26 Oct 93*

[Text] Paris, Oct. 26 (AFP)—British Aerospace (BAe) and the French group Matra are thinking of agreeing by the end of the year to form a joint company to build missiles. BAe managing director Dick Evans said on Tuesday.

The two companies intended to form a joint venture, in which each country would have a stake of 50 percent, Evans said. He also observed that the distribution of capital did not necessarily mean an equivalent distribution of power. The two companies could not hope to continue as major forces in the field of fighter aircraft if they did not find a way of working together, Evans also said.

In an interview with the *Les Echos* newspaper here he said that the two companies were each investing in similar fields of research and technology. They would rationalise this if they could find a way of doing so and were talking to each other regularly to identify such opportunities.

Rationalisation of the European aeronautical industry affected fighter aeroplanes, Evans said.

Thomson-CSF To Inaugurate Advanced Radar, Countermeasures Center

*94WS0057A Paris LE MONDE in French
25 Oct 93 p 24*

[Article by P.S.: "Thomson-CSF Employees Being Relocated to New Elancourt Site"]

[Text] In less than three months, 1,600 Thomson-CSF employees have converged on the new ultramodern headquarters facility at Elancourt for the radars and countermeasures division (RCM).

By 31 December a total of 1,800 employees will have pulled out from dismembered and obsolete facilities at Malakoff, Montrouge, and Issy-les-Moulineaux to regroup in a futuristic 66,000-square-meter structure designed by architect Roger Taillibert (who did Montreal's Park of Princes and Olympic Village) and built in record time on the outskirts of Saint-Quentin-en-Yvelines.

"This relocation was urgent and critical for us. Beginning next year, our operating overhead will be reduced considerably and our productivity optimized," said Bernard Rocquemont, director of the RCM division, which devotes one-third of its efforts to research and development of new civilian and military radars.

The opening of this luxurious but indispensable sanctuary of French electronic-warfare technologies, where 1,100 technicians and engineers have converged since August, coincided infelicitously with the announcement of a reduction-in-force plan that will affect 1,600 Thomson-CSF employees, including some at Elancourt.

During a tour of the site given for the press and local officials, Rocquemont tried to dissipate worker anxieties by confirming the objectives as originally announced. As of 31 December, 1,800 persons will have been transferred to Elancourt. "Thomson has decided to work with the government in an effort to come up with an alternative to layoffs, in accordance with the provisions of the new five-year employment law. There will be some retirements and some reduced work-weeks," he said.

But the Thomson-RCM director was loath to speculate on a completion date for phase two of Elancourt, which by 1995 was supposed to be supporting some 3,000 employees. Land has already been purchased, but there will be no announcement of expansion until currently half-empty order books begin to fill up.

The profitability of the RCM division—which had 3.4 billion French francs in sales in 1992 and employs an additional 1,100 people in Brest and 660 in Pessac (Gironde)—depends on military and civilian aeronautical equipment programs which have been hit hard by the recession.

France: Matra Develops Europe's First Air-Air Multitarget Missile

*BR1410101193 Paris LA LETTRE DU GEFAS
in English 16 Sep 93 p 1*

[Unattributed article: "Matra: Authorization for Multitarget Capability of the Mica Missile"]

[Text] A highly significant firing of Matra's air-air missile Mica was recently made from the Landes Test Center using a Mirage 2000 aircraft. The test is part of the development phase of this missile for which Matra Defense was appointed prime contractor in 1987 by "The General Arms Directorate Missiles and Space Division." The Mica, fired from a Mirage 2000 operated by the Flight Test Center Cazaux base, was capable of discriminating, pursuing, and then intercepting a target previously designated within a maneuvering patrol group. This capability, demonstrated within a complex environment, clearly indicates the multitarget character of the weapon system comprising the Mica missile and carrier aircraft. This successful operation makes France the first European country, and one of the world's first, to develop air-air systems with multitarget capability.

Following on the heels of earlier successes, this test marks a major stride in the development program. Program costs have been kept strictly within set limits, far below investments made by other countries to achieve this capability. The Mica program aims at providing a multitarget, multipurpose missile for use by the Navy and the Air Forces for use in conjunction with the Mirage 2000-5 and, later, the Rafale aircraft. It should be ready for operation by 1996 for service under the most stringent operational conditions, for sophisticated electronics warfare. The Mica, with active electronics guiding or infrared image, will be the first air-air missile in the world capable of neutralizing aircraft, helicopters, missiles, or drones in active combat from very short to extended ranges (well beyond 60 kilometers). The Mica is compact and light and particularly well adapted to being carried in significant numbers by future fighter aircraft such as the Mirage 2000-5, Rafale, Gripen, EFA [European Fighter Aircraft], etc. It would also update existing fleets by greatly increasing the firing power and versatility of each aircraft (Mirage 2000, F-16, Tornado, etc.). Two countries have already placed orders (for approximately 2,000 units) for the Mica missile two years before going into production. For more information, contact Mr. F. Aragon at Matra Defense; phone: (+33) 40-69-16-74.

France: Army Installs Convex Supercomputer for Weapons Modeling

BR0311155493 Edam SUPERCOMPUTER
EUROPEAN WATCH in English Sep 93 p 3

[Unattributed article: "French Armaments To Be Modelled on a C-3840"]

[Text] France's defence policy relies on a strategy of overall deterrence. To optimise its land-based defence equipment, the French military establishment has begun to use a four-processor Convex system.

Earlier this year, a French Army computer centre installed a Convex C-3840 to be used for real-time applications and numerical simulations. The four-headed system is configured with 512 Mbytes of physical memory and 4 Gbytes of disk. It connects, via an FDDI [fiber-distributed data interface] network, to about 35 workstations and 25 X-terminals. The system will run with a real-time kernel coupled with a Unix-based environment.

The French General Arms Delegation (DGA) is responsible for all French weapons programs, either through manufacturing or contracting with industry for equipment. The DGA has several divisions; land weapons fall under the jurisdiction of the Terrestrial Arms Directorate (DAT), which is responsible for research, technical testing, and procurement of land weapons equipment.

A division of DAT is the Angers Technical Establishment (ETAS), established in 1950 southwest of Paris, near Angers; it is in charge of army vehicles. The types of

equipment tested by ETAS range from large hydraulic-powered systems and components; to suspension equipment, for all sorts of motor vehicles and components such as tanks, trucks, and fire equipment; plus amphibious equipment and even floating bridges.

The facilities in and around Angers include a data processing centre (CI), where ETAS runs dynamic modelling in which a critical component of a vehicle (e.g., the gears) is interfaced with a computer model running on the Convex system. This dynamic modelling will result in extremely realistic and accurate simulations. In addition, ETAS will develop applications to analyze new equipment for speed, acoustics, and ballistic shocks.

The contract for this system—including software—amounted to some ECU 4.5 million. In the end the number of competitors was narrowed down to two: Cray and Convex. "The Convex system was selected for the superior performance of its processors, and because of the real-time possibilities as well," says Christian Lalande, director of the Data Processing Centre at ETAS. He considers the experience so far to be good. "We are in the process of learning how to use this machine; we installed software coming from our old (Prime) installation."

Germany: Eurofighter 2000 Faces Additional Problems

MI0311163893 Bonn DIE WELT in German
20 Oct 93 p 14

[Article by Reiner Gatermann: "Eurofighter in a Spin: Rumors of Dasa's Withdrawal; Technical Problems Over Control Systems; Development Time Overshot"]

[Text] The Eurofighter, or Fighter 2000 (EF2000), the combat aircraft for the next century, continues to be beset by problems. The Munich headquarters of this four-nation project recently announced the further postponement of the maiden flight, to enable additional tests to be carried out. This is a tactful euphemism for the problems being experienced with the flight control system. In addition, an extremely critical report by the Federal Audit Office on the project efficiency is to be published during the next few days. Meanwhile, London has tuned into the hints emanating from the German aviation industry that Daimler-Benz, whose Dasa [German Aerospace] subsidiary is the German EF2000 partner, is not too keen on its involvement in military aviation and is trying to withdraw.

The crash of the Swedish Gripen in August, together with the previous one by the American F22, did not leave the EF2000 developers entirely unscathed. All three airplanes have the same flight control system, except for the American one, supplied by the British company GEC-Marconi. Although Saab has at least managed to develop a system which, while clearly not perfect, is at least fit to fly, the European partners have not even been able to integrate the GEC and Dasa flight control components into an functioning system. For this

reason, the Gripen crash provides a welcome excuse for postponing the maiden flight. Very probably, it would have had to be postponed in any case, due to other problems of an even more basic nature. British aviation circles hope it will now at least be possible to present the EF2000 at the Berlin and Farnborough Shows in 1994.

The content of the Federal Audit Office's report, presently before the Bundestag's Defense Committee, gives little cause for the excitement generated in London, as its criticisms "have been well-known for some time."

"Less understandable," however, is the remark that the Eurofighter is less effective than aircraft already available. Such a claim is stated to show "a lack of specialist know-how," as the EF2000's capability "starts at the point where those of other airplanes, such as the F16 or the MiG29, leave off."

In its report, the Federal Audit Office also criticizes the 30-month overrun of the development period, the postponed maiden flight and the "costs which have far overshot the budget." British figures suggest costs have risen by 25 percent, from 19.6 to 24.5 billion German marks. There are, however, plausible reasons for this, including changes in planned requirements, and, not least, the attempt by Federal Defense Minister Volker Ruehe to withdraw from the present project.

Although the British are getting nervous about the constant delays, another factor has added to their concern: The suggestions originating from Germany that Daimler-Benz is not interested in military aircraft construction and is considering withdrawal. "Though this is repeatedly denied, the denials sound half-hearted," states a member of the parliamentary Defense Committee. However, when questioned on this, Dasa spokesperson Christian Poppe replied that "Dasa has no intention to withdraw from the Eurofighter project."

Such a decision would have caused enormous concern among all those involved. Though the view was expressed in Britain during Ruehe's campaign for a "new" Eurofighter that the industry would benefit from Germany's withdrawal, the feeling now is that the project cannot succeed without the Germans—particularly not financially. The present balance between the British and German partners (each with 33 percent) and the Italian (21 percent) and Spanish (13 percent) partners is going well, stated a spokesperson for the Defense Ministry, who added that their wish is now to finally see the fighter in the air.

Viewpoint

German Government circles portray British assumptions that the German industry, and particularly DASA, wishes to withdraw generally from military aircraft projects, and specifically from the EF2000, as a misunderstanding. The issue is different, according to Bonn: The project's complexity requires specific components to be concentrated in one pair of hands. The particular area in mind is the flight control computer and software,

where both German and British firms are involved. The German opinion is that it would be better to concentrate this work in one pair of hands, so as to avoid future complications arising from organizational structure. The Germans are sounding out opinion in London as to whether the British would agree to such concentration of these components: DASA would be willing for them to be in either British or German hands. If the British wanted to assume sole responsibility for flight control and software, then DASA would in return expect another part of EF2000 development work to be handed over to Germany.

ENERGY, ENVIRONMENT

Germany: Altered Bentonite Improves Sewage Treatment

93WS0709B Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 1 Sep 93 p 8

[Article by "toz": "Altered Bentonite Improves Sewage Treatment. Jülich Research Center's Process Functions As Recycling System"]

[Text] Frankfurt—Process engineers at the Institute for Physical Chemistry of the Jauulich Research Center GmbH [Limited Liability Company] have succeeded in removing quickly and almost completely from sewage by means of iron bentonite a number of complex organic compounds. Iron bentonite was obtained by the chemical alteration of naturally occurring bentonite. The process functions as a recycling system and therefore is supposed to be run relatively cost effectively.

The institute reports that the process was developed under varying conditions in the laboratory and has been tested to the extent that it can now be used in practice in pilot plants. It is suited for the removal of anilines, pesticides and herbicides, phosphates, heavy metals and other chemicals that have the basic structure of aniline.

Bentonite has already been used up to this time for purification, for the most part of aqueous media, because of its high adsorption capacity. Its adsorption capacity was able to be increased strongly by its alteration to iron atoms instead of sodium or calcium. Measurements have shown that iron bentonite has an adsorbing capacity of up to 1.6 millimole per gram. This represents for aniline alone an adsorbing capacity of 16 percent by weight per gram of iron bentonite.

The adsorption is irreversible and takes place relatively rapidly in the case of the closely studied removal of aniline. According to the developers' observations it takes on average from 15 to 20 minutes and ends with equilibrium between the adsorbed aniline and the residual concentration in the water.

The adsorption depends on the hydrogen ion concentration (pH) here. It is canceled again in an acid environment, at around a pH of 6. The aniline can thus be

separated from the bentonite again, and the bentonite is available again for a new operating cycle. The separated aniline can be processed or destroyed. Bentonite is available in sufficient quantities as mineral raw materials. Natural sodium and calcium bentonites can also be converted cost-effectively to iron bentonite. Bentonites are clay minerals that originate via the decomposition of volcanic tuffaceous rock. They are counted among the montmorillonite group and consist of various mixtures of aluminum oxide and silicon dioxide. They have a characteristic layer crystalline structure whose specific properties are determined by the intercalation of metals and water molecules.

Bentonites are naturally occurring ion-exchange compounds. They have catalytic capabilities, swell strongly under the action of water and have been used for a long time already for the clarification of cloudy suspensions, of wine and beer, for example. They have various names according to where they are found—like terra di Siena and montmorillonite (Montmorillon, Department Vienne [Province of Vienne], Southern France).

UK: CFC Damage to Ozone Layer Also Found to Occur in Temperate Zone

93W50709D Frankfurt/Main FRANKFURTER
ZEITUNG/BLICK DURCH DIE WIRTSCHAFT
in German 1 Sep 93 p 8

[Article by "dpa": "CFCs Doing Double Damage to the Ozone Layer"]

[Text] London—Scientists at Cambridge University in Britain have discovered another chemical mechanism that, as chlorofluorocarbons (CFCs), can damage the ozone layer. Ralf Toumi's team reports in the British journal NATURE that model computations have shown that this ozone loss is not limited to the polar regions of our planet, but can also occur at temperate latitudes. Chloronitrate, a decomposition product of CFCs that hitherto was considered inactive and harmless, can under certain conditions also attack ozone. This happens in the late spring, when the sun appears again over the polar regions and the icy stratospheric clouds break up. Because chloronitrate in the upper layers of the atmosphere can be transported to temperate latitudes from the antarctic and arctic regions, it can also exert an effect at these latitudes. According to the model computations, a substantial part of the ozone loss observed at warmer middle latitudes of the earth could be ascribed to this mechanism.

Germany's Largest Wind Energy Device Installed

94W50085B Frankfurt/Main FRANKFURTER
ALLGEMEINE in German 3 Nov 93 p N3

[Article: "The Largest Wind Converter"; Subheadline: "Aeolus II at Wilhelmshaven/3 Megawatt Output"]

[Text] In mid-October, what is currently Germany's most powerful wind converter was put into operation.

The Aeolus II prototype, set up Wilhelmshaven, is designed for three megawatts. Its output is nearly six times as much as the largest standard systems. The tower is 92 meters tall and the diameter of the rotor totals 80 meters. Projected annual energy production is nearly 7.3 gigawatt hours. This is equivalent to the average consumption of almost 2,000 households. The Swedish firm Kvaerner Turbin AB and Messerschmitt-Boelkow-Blohm [MBB] Foerder-und Hebetchnik GmbH in Delmenhorst built the system.

Large wind converters have been growing increasingly popular for some years now. The reason is that the number of sites with sufficiently high average wind velocities is severely limited. In Germany they are concentrated along the coastal regions and the higher altitudes of low hills. Large converters make better use of such site since they occupy less space than the farms with their numerous small systems. But the technical requirements go up in tandem. As an example, carbon fibers, among other things, were used for Aeolus II's rotor blades. This resulted in a halving of the weight. The extent to which a system is economical, however, also depends on investment costs. The so-called specific costs, the price of a converter divided by its rated output, in the 150-500 kilowatts range, for example, are about DM2,000 per kilowatt hour. It is moot whether this value increases for larger systems.

With support from the European Community, a number of European manufacturers are presently working on bringing systems of approximately one megawatt to the point of serial production readiness. They should be available in 1995. At that time too, it will be determined whether Aeolus II met the expectations placed in it. Operator Preussen Elektra Windkraft Niedersachsen GmbH, Niedersachsen state, the federal ministry for research and technology and the European Community absorbed the costs totaling DM25.5 million. Development of the rotor blades by MBB cost an additional DM6 million.

Italy: Fiat, Environment Ministry Accord Presented

MI2110153793 Rome AMBIENTE (Supplement to
No. 43) in Italian Sep 93 pp 1-5

[Text] Environment and Urban Areas Minister Valdo Spini and Fiat Managing Director Cesare Romiti signed an agreement on 28 June 1993. The protocol of agreement, which describes Fiat's undertakings in the environmental field, is reproduced below in full.

The document follows along the line of the existing collaboration between the ministry and the Fiat group. There were two preceding agreements, one in 1989, and the other in 1991. The goal of this latest agreement is to define the most important environmental programs that Fiat is working on, making them obligatory, and inserting them into the more general activities that have been started by the Ministry of the Environment to

improve the quality of life in the urban areas and to reduce the impact of industrial activities on the environment.

INTRODUCTION

The Ministry of the Environment and Urban Areas and Fiat agree upon to need to base the procedure for sustainable development on a mutual and collective pledge, made by both the public administration and the business world.

The Ministry of the Environment and Urban Areas and Fiat believe that this pledge, which forms part of the evolving environmental norms, must be manifested by convincing concrete actions so that the culture of industry and social awareness develop toward a conduct that is compatible with the environment.

Some initiatives, which are aimed at attaining the objectives that are the subject of this protocol, are described below.

THE RECYCLING OF AUTOMOBILES AT THE END OF THEIR LIVES

General Aspects

When an automobile has reached the end of its useful life, it presents a problem today for its owner in Italy because there is no standardized procedure for its withdrawal by organizations that guarantee homogeneous conditions as far as economic treatment and service (for example the cancellation of the automobile from the public vehicle register, the withdrawal of batteries, etc.) are concerned.

Withdrawal is normally effected through networks of collectors/demolishers who do not always possess the necessary authorization.

The old automobiles usually remain in these centers for a period that varies between a few months and over a year. The centers generally dismantle the components that are most commonly required (and put them on a third level market that does not guarantee either quality or safety).

Because little care is taken, and because these centers lack equipment for the treatment of the components that have the most critical impact on the environment (batteries, fluids from technical systems, fuels, etc.) diffuse pollution is often found in the ground on these sites. Consequently the need has arisen for a revision of the collection and demolition procedure for automobiles that have come to the end of their lives, and that puts some order into the current system and enables the following objectives to be attained:

- a. The transportation of automobiles to be demolished to authorized centers that are able to respect environmental regulations;
- b. Making it obligatory for the vehicles to be made safe from an environmental point of view (dismantling

batteries, emptying liquids, etc.) before any other demolition operations are performed;

- c. Identifying methods of utilization, which do not incur economic losses, for a large part of the materials contained within the automobile that are thrown away today after the car has been scrapped; the recycling of plastic materials must be a primary objective;
- d. Identifying methods of recovering energy from materials that have a good caloric potential, that cannot be dismantled selectively, and would be destined to be thrown away.

Program

Fiat has faced the problem of the collection and scrapping of automobiles by starting some preliminary activities. An experimental dismantling center has been set up, plastic components are being coded and various substances that are damaging to the environment (asbestos, cadmium, chlorofluorocarbons) have been eliminated. Concrete possibilities have been found for the recovery of materials, particularly for reuse within the automobile sector.

Fiat launched a pilot experiment, called FARE [Fiat Auto Recycling], in September 1992. This involves other private operators within the context of a system that enhances their role.

In practice the goal is to verify the technical and economic possibilities for the recovery of plastic materials and glass, improve the quality of the steel, which is already traditionally recovered, and experiment with the utilization of nonmetallic components that cannot be reused as materials in energy production.

This latter part will be developed by looking for uses both in steelworks and in cement factories. Both these processes require large amounts of energy and temperatures that are high enough to give adequate assurance in environmental terms on the quality of the emissions, particularly with respect to micropollutants.

The experiment is planned to finish at the end of 1993. The system was launched with six collection centers and already, today, there are 25.

In order to transform FARE into a national system it would be necessary to exceed the territorial limits of an experience that already has good prospects for development. However the following legislative measures are indispensable:

- a. The establishment of authorized centers for the collection and demolition of automobiles. Specific technical legislation must be issued for these centers and this must be respected in order for authorization to be given;

- b. The introduction of a certificate of demolition to be issued by an authorized center when it takes responsibility for a vehicle. This document will have to be presented, together with those that are already required under current legislation, in order to remove the vehicle from the public register of automobiles;
- c. Limiting the possibility of trading in spare parts that have been salvaged from scrapped cars to only those components with no bearing on safety.

A technical committee comprising some of those who were involved in the experiments and representatives of the Ministry of the Environment and Urban Areas is to be set up. Its goal will be to follow the development of activities in order to gain both technical and legislative suggestions.

On the basis of the results of the work of the committee, the Ministry of the Environment and Urban Areas commits itself to activating the other competent ministries and the institutions involved in order to obtain legislation that regulates the entire sector at a national level, in line with the objectives that have already been mentioned, starting from the updating of the legislation on secondary raw materials.

ENVIRONMENTAL MANAGEMENT IN FIAT

General Aspects

At an international level it has already been noted that the management of the relationship between industry and the environment based on the traditional system of "command and control" causes such rigidity that it prevents legislation from adapting rapidly to environmental and socioeconomic factors.

Important improvements in the environmental field are not just the results of technological advancements, but also of the correct and continuous management of activities in relation to the environmental impact that they could create.

The proposal for European Community regulations on ecological management and audit emphasizes this aspect of management and orients companies toward the adoption of diffuse control systems that assure environmental quality for the various processes involved in manufacturing operations.

An improvement in the information given both to management and to the community is just as important, both in terms of quality and completeness. In fact the regulations provide for the preparation of a periodical, certified, environmental declaration.

Program

Fiat has already started to develop an environmental management system by organizing the necessary structures in its own factories and perfecting appropriate methods and procedures. Fiat has also obtained the inclusion of the Verrone factory, which produces mechanical components, in the EC pilot project in order

to verify whether these regulations could be applied in other national factories and sectors.

The goal is to gradually introduce this management system into all the factories, including the new factories at Melfi and Pratola Serra.

Fiat will publish all the information relating to the principles and methods that make up the system, indicating in particular the problems that have arisen from the adoption of specific methods, as far as implementation and organization are concerned.

The Ministry of the Environment and Urban Areas will nominate a technical support organization to prepare this information and that must show compliance with the regulations currently in force.

REDUCTION OF EMISSIONS

Evolution of Vehicles and Fuels

General Aspects

The two types of technical intervention to be made in order to obtain further reductions in vehicle emissions, according to the norms that have already been established by the European Community and those that are being defined for the mid-nineties and the end of the nineties, are the development of engines that have been optimized to achieve low emissions and the improvement of the quality of fuels. The latter is becoming a requirement that cannot be renounced as engine technology evolves toward higher levels of sophistication.

Fiat is investing considerable resources into the development of petrol and diesel engines in view of the increasingly binding legislation.

Briefly, the pledge to research provides for:

- In the medium term, the definition of innovative strategies for feed control, the optimization of the efficiency and life of catalyzers, the perfection of rapid activation catalytic systems;
- In the long term, the development of more sophisticated devices for catalyzation and direct injection as well as specific devices for diesel engines;
- Furthermore, Fiat is developing engines that use alternative fuels (in particular methane), and in particular for vehicles circulating in urban areas since they allow very low emission levels to be obtained.

As for fuels the improvement in their quality must take into account, both in the short and medium term, the necessity of using them on vehicles that are not fitted with catalytic converters, with noteworthy immediate benefits.

The long-term goal (considering the limits on emissions that could be hypothesized after the year 2000) is a drastic reduction in the harmful components and their substitution by oxygenated products that have a low impact on the environment.

Program

Fiat confirms its pledge to the Ministry of the Environment and Urban Areas to constantly adapt to new emission standards through the above-mentioned medium and long-term research and development and, as far as fuels are concerned in particular, offers its own contribution aimed at assuring their compatibility with the evolution of motoring.

The Ministry of the Environment and Urban Areas undertakes to continue with the effort already being made to accelerate the improvement of quality levels for fuels as far as the environment is concerned (benzene, IPA [no expansion provided], sulfur, etc.)

Field tests will be conducted in medium-sized cities to verify the improvement of air quality following the adoption of improved fuels.

The Ministry of the Environment and Urban Areas will establish how the tests are to be conducted in agreement with Fiat and with the petrol companies that are willing to participate in the project.

Collective Transport**General Aspects**

A changeover from individual to collective transport would be one of the most effective methods of containing the increase in traffic and the pollution deriving from it.

In Europe, the cities that are facing the traffic problem and achieving the best results are those that have a public transport network subdivided into vehicles driven on rails and road vehicles. Also in these cities, the buses that are used in the city centers and on routes where there are a large number of passengers are the strong point within an integrated, intermodal system.

In the short term, a qualitative and quantitative improvement in the role of the bus would be a determining factor for traffic flow in the most congested cities.

In fact, buses can be used flexibly and do not require investments for the construction of infrastructures. At most they require lanes, dedicated exclusively to public transport, that allow sufficient average speed.

In recent years there has been a visible reduction in investments for the purchase of new public transport vehicles in Italy. This has been the result of financial, legislative, and management factors relating to local public transport. The most serious consequence has been a further aging of the fleet. Recently, the temporary block on investments made by the companies has brought purchases to a standstill.

Therefore we have reached a situation of a widening gap between demand and supply. On one hand there is the need to renew and increase the fleet with more efficient vehicles that are safe and ecological, and on the other

hand industry is not receiving orders although it would be able to supply vehicles that are more evolved, modern, and valid.

Program

In recent years Fiat has dedicated considerable resources to the complete renewal of its own range of buses in order to improve accessibility, reduce noise and vibrations, and achieve a substantial reduction in emissions. As far as the latter is concerned, much better results have been attained by direct interventions on the engines and the adoption of systems for the reduction of fumes (particle traps).

A methane bus has been developed. This has minimal emissions and opens up the road to widespread experiments into this particularly ecological alternative fuel.

Hybrid buses have been built so that city centers can be crossed using electric engines and consequently without producing emissions.

It is thought that both types of nonconventional vehicles should be used experimentally in fleets of 20/30 vehicles in large cities over a period of two years.

The technical results, the evaluation of costs and benefits, and acceptance by the companies and by the public, should confirm the validity of the solutions.

The municipal bus company of Ravenna has already started to experiment with the use of methane-fueled buses. The completion of this experiment is considered to be particularly significant. This experiment plans for the changeover of the entire fleet to methane through the purchase of new buses, and for the conversion of some diesel buses by Iveco which is fitting new engines that have been designed to run on methane. It will make significant pilot experiment results available both nationally and internationally. These will be both technical results and economic evaluations.

Fiat will continue with its investment program for the evolution of diesel vehicles and the validation of alternative solutions.

The Ministry of the Environment and Urban Areas will use financial mechanisms to promote the introduction of ecological vehicles (fueled by methane, electrically driven, and hybrid) into the fleets of buses belonging to the transport companies. Such actions will permit, amongst other things, an improvement in industrial programming and this will have important spin-offs on employment.

Measures To Accelerate the Diffusion of Low-Emission Vehicles in Large Urban Areas**General Aspects**

The critical condition of the quality of the air in many cities makes it necessary to resort to the radical interventions provided for, in cases where alarm levels are

reached, by the decree of the Ministry of the Environment and Urban Areas. This enforces a series of measures to accelerate the process of evolution toward a fleet that is fitted with catalytic converters and is more suited to the specific environmental needs of urban centers.

—Priority is to be given to effective and frequent testing of the vehicles in circulation. If tests are carried out with the frequency laid down in the new highway code, which has been brought into line with European standards, this can certainly make a strong contribution toward improved maintenance and to singling out those vehicles that are ecologically most obsolete. This testing must be started as soon as possible. The administrative problems that are delaying this essential action, which will reduce the emissions caused by traffic, must be surmounted quickly.

—A second measure that would certainly be effective, would be to anticipate the renewal of the fleets belonging to local authorities and institutes and mainly used in urban areas.

Great benefit could certainly be gained from substituting them with vehicles that are less polluting.

—One measure of noteworthy effectiveness for the containment of emissions in cities that have particularly critical environmental situations, which conforms to urban mobility plans and programs for the improvement of the quality of the air, could be to only allow vehicles that conform to directive 91/441 to circulate. This would lead to an increase in the number of ecological vehicles in circulation.

This initiative should form part of the plan for "urban mobility and the environment" put forward by the Ministry of the Environment and Urban Areas and the Ministry of Transport. This plan provides for the definition of technical-environmental specifications for vehicles that can circulate in the cities in accordance with an established calendar/purpose.

—Fiat has a series of company programs on electrical traction. The goal of these programs is to develop various types of vehicles. However, it is opportune that provision should be made for programs, and that there should be incentives, for extensive testing with automobiles and electric vehicles that have safety characteristics comparable with those of the vehicles currently in circulation, and that these vehicles should be gradually introduced into urban traffic for specific purposes.

In fact the vehicles that are already available need to be put through a wide range of tests, that can validate their technology and identify their uses, as well as study their compatibility with other means of transport.

Program

In general, the Ministry of the Environment and Urban Areas will act to encourage the launching of all the

initiatives listed, facilitating their realization, and publishing their results. In particular, as far as the renewal of the fleets of public and private vehicles used in the large cities is concerned, Fiat undertakes to make provision for commercial strategies and to give adequate support to the Ministry of the Environment and Urban Areas as far as educational/informative initiatives aimed at the substitution of obsolete vehicles are concerned.

Fiat will continue with its research and development into innovative solutions that will increase the use of electrically-driven automobiles, commercial vehicles, and minibuses.

The Ministry of the Environment and Urban Areas will draw up a package of incentives that will encourage public bodies and organizations to build up display fleets.

PILOT PROJECT FOR A SYSTEM OF INTEGRATED METROPOLITAN MOBILITY WITH THE GOAL OF OPTIMIZING THE RELATIONSHIP BETWEEN TRAFFIC AND THE ENVIRONMENT

General Aspects

Fiat has a long experience in urban mobility. This includes studies, design and engineering, as well as construction in the factory of systems, infrastructures, and ecological vehicles both for the individual and for the collective transport of people, and for the transport of goods.

In synthesis, this experience relates to a series of interventions that have all had the goal of reducing the impact of traffic on the environment and of improving the relationship between the automobile and the city.

These areas of intervention are complementary to those for the technical updating of new engines, for devices to reduce emissions, and for improvements to the quality of fuels.

In particular, these areas cover:

- a. For systems, traffic models, methods for an integrated approach to urban transport systems, carrying out operations connected with the control and management of traffic, as well as real-time information for the user and the monitoring of meteorological and environmental conditions;
- b. For infrastructures, the design and construction of various types of automatic and nonautomatic car parks, the construction of tramways and subways, and intermodal infrastructures;
- c. For nonconventional ecological vehicles, buses and electrical distribution systems, hybrid buses, special vehicles and buses fueled by methane.

The initiatives that have been taken by the various Italian municipalities to improve mobility and to safeguard the environment have been characterized by a

prevalently sectorial approach. Even today we do not have enough experience in the organization of valid, multidisciplinary experiments of a significant size and aimed at achieving goals and maximum efficiency.

Program

Fiat considers that it is fundamental for these integrated initiatives to be set up in accordance with plans that are agreed upon with the Ministry for the Environment and Urban Areas. This should lead to projects, for which feasibility studies are planned, and developments whose results are evaluated.

Tests and verifications should be effected in order to make a critical study of the innovative technological solutions that are coherent with the goals of easing traffic flow and reducing emissions.

Fiat will make a concrete contribution to feasibility by singling out contributory factors, identifying the types of intervention and goals, and indications of the financial resources necessary and the relative sources.

To give an example, the municipality of Bologna has started an initiative to study the compatibility of the development of mobility with the urban ecosystem through the POSTER (The Scientific and Technological Pole of Emilia Romagna) consortium which unites public and private resources.

This initiative, given the significant concordance of its goals with those of this protocol, could become the symbol of the first experience of a pilot project. The Ministry of the Environment and Urban Areas will sponsor the project and also work toward the awareness and involvement of other ministries, local authorities, research centers and institutes, both nationally and abroad, to make them participate in the pilot project and give it appropriate financial support.

THE TREATMENT OF WASTE PRODUCTS

General Aspects

Waste disposal is certainly one of the most serious problems today. Not only as far as toxic and harmful waste is concerned, but also as regards the less dangerous waste, because the disposal capacity is notably inferior to that which is effectively necessary.

According to the regulations currently in force, the producer must give priority to the disposal of his own waste or, alternatively, make provision for this to be done by authorized third parties. Furthermore, all the laws concerning waste state that the first objective should be to recycle as much of the waste produced by production processes as possible, in order to reduce the amount of waste to be thrown away. Starting from these considerations, Fiat, which has about a hundred production units distributed throughout the country, has made a valid and notably effective response through the development of its Fenice system. The waste products produced by the factories and destined to Fenice are "special," with a modest percentage (5 percent) of "harmful

toxic," waste that is mainly made up of used solvents. Their heterogeneous origin does not have any effect on their composition.

The Fenice System

The goal of the Fenice system is to:

- 1) make the maximum use of technologies and products for the recovery and recycling of waste, physiologically reducing the quantities to be thrown away and their harmfulness;
- 2) effect maximum controls at every stage of disposal.

The Fenice system has four essential components:

- A system to control the generation of waste, allowing for the definition of the optimum minimum quantity for each single stage of the production process, and effecting selective collection geared to recovery;
- peripheral pretreatment centers, the so-called ecological islands, at each factory belonging to the group. The goal is to select and pretreat waste, assuring that it constantly conforms to the specifications provided for, and to prepare the waste for recycling and the successive transport;
- a logistic transport system for waste that provides for the use of special vehicles to guarantee safety and makes extensive use of railways;
- the creation of three integrated thermal destruction platforms for the recovery of energy and to render the waste products inert and dispose of them, with a total treatment capacity of about 250,000 metric tons per annum, located according to the positions of the production centers in northern, central, and southern Italy.

The solution of thermal treatment has been chosen instead of directly dumping since the latter does not resolve the problem but simply delays it and increases the margins of risk.

Once started, the Fenice system will allow Fiat to keep its flow of waste under constant control from the moment of its generation, through the phases of transport, to recovery, or final disposal.

The technological solutions adopted will be the most advanced for the protection of the environment.

The program has started. The relative requests for authorization are at the approval stage.

The Ministry of the Environment and Urban Areas takes note of the Fiat initiative. It will be given the necessary attention, also with respect to the estimated evaluation of its environmental impact since it is considered to be significant for the national system of waste disposal.

The Ministry of the Environment and Urban Areas places central importance on the use of waste products as

alternative fuels, both to resolve environmental problems and to make our country more independent as far as energy is concerned. (Turin, 28 June 1993)

Netherlands: Projects at Energy Research Center Summarized

BR2110161293 Amsterdam RESEARCH PLUS RESULTS in Dutch Sep 93 pp 17-19

[Article by Ria Hooghiemstra: "Profile: Petten Research Center: Cooperate With Market Place on Energy Innovation"]

[Text] Renewable energy, fossil fuels, nuclear energy, and energy policy. The Netherlands Energy Research Center Foundation (ECN) is active in all major areas of energy research. In the forefront is the quest for techniques and measures which will make the provision of renewable energy possible. The keywords for ECN are innovation and collaboration with industry. To demonstrate how much importance is attached to this collaboration, 1993 has been declared the "Year of Industry." "Because," says Professor van den Kroonenberg, managing director of ECN, "energy innovation can only really be brought about by contact with the market place."

Even a casual visitor to the dunes area in Petten, where ECN is situated, would instantly realize that energy is the main interest. Just inside the entrance an experimental windmill is turning, while a short walk around reveals an array of solar batteries as well as the outline of a small nuclear reactor. All are at a suitable distance from each other. Spread out among the various buildings, research staff are hard at work.

Undisturbed

By definition, the provision of energy requires a long-term view. Not only because the life span of the average power station is 20 years and decisions made now will have an effect far into the future, but also because of the overriding importance of the continuous provision of energy. ECN's vision is most clearly apparent in the ENGINE (Energy Generation in a Natural Environment) research program, into which it has invested about 10 percent of its research capacity. The basic assumption here is that in the future all energy needs must be met from renewable sources, which above all must produce no damaging emissions. That will entail a comprehensive improvement in the provision of energy, something which cannot be done between one day and the next. For the time being, that is to say for at least the next 50 years, use will be made of a mixture of long-lasting fossil and nuclear energy sources. ENGINE's motto is: "Fossil fuel which is affordable, durable, and clean; and safe nuclear energy."

Renewable

Renewable energy sources such as solar and wind power, which are not reliant on the Earth, will in the end be the

only energy sources capable of ensuring that the rising energy needs of the world's population will be catered for in years to come. These energy needs will be primarily be the result of the growth in Third World economies. The Netherlands already has practical experience in the production of solar and wind energy. At the moment, however, the energy produced in this way is still too expensive while the relevant technology is insufficiently developed. In order to prevent future energy provision problems, these technologies have to be developed promptly and adequately. Solar energy, the generation of energy by means of solar cells, is also an attractive energy source for the Netherlands. At the moment, research into affordable solar cells is the fastest growing part of ECN's program. In research into fossil fuels, the accent is being laid on the development of energy generation methods which are more environment-friendly than the present combustion systems being used in electricity power stations. The development of fuel cells, in which the energy is gained by means of an electrochemical process, is currently ECN's primary target. The fourth generation of nuclear reactors must be able to provide a safe nuclear future. These are so designed that if there should be a breakdown, the nuclear reactions would automatically come to a stop. In the meantime, ECN has decided to begin research into the possibilities of building a demonstration reactor in the Netherlands. It is hoped that this will lead to a concept design in which Netherlands industry can also play its part.

Daily Practice

The ENGINE program includes ECN's most advanced research being directed toward long-term results, and is to be financed from its basic subsidy. The daily routine of the research work will be decided by more directly applicable projects, for which the financing primarily originates from national (EZ-VROM) [Ministry for Economic Affairs—Ministry of Housing, Regional Development and the Environment] and international programs such as, for instance, JOULE [Joint Opportunities for Unconventional or Long-term Energy Supply] and THERMIE [European Technologies for Energy Management]. Finally, the commercial world also contributes: Mr. van den Kroonenberg estimates that between 10 and 20 percent of the financing for the project comes from commercial firms.

Collaboration with industry often takes the form of a project in which ECN and companies work together, and the EC or national governments partially subsidize the project. An example of this is a project in which fuel cells are being manufactured on a semi-industrial scale. It is testing a so-called fuel cell stack on the basis of molten carbonate cells with a capacity of 2 kW. Two stacks, each of 250 kW, will be constructed. In order to carry out this project, BV Brandstofcel Nederland [Netherlands Fuel Cell Ltd.] (BCN) has been set up, of which the Netherlands companies Stork and Schelde each hold 49 percent, and ECN, 2 percent. An international example is the work on an experimental type of fuel cell on the basis of ion-conducting ceramics. This research is being carried out within the framework of EC the programs JOULE

and BRITE-EURAM [Basic Research in Industrial Technologies for Europe / European Research in Advanced Materials], together with Siemens, the French company GEC-Alsthom, and Britain's Imperial College.

License

Another potential form of collaboration between a company and ECN could take the form of joint research into a commercially interesting product, after which the company enters into a licensing agreement with ECN. A ceramic burner, which produces much lower damaging nitrogen oxide emissions than the normal types of central heating boilers, has been developed within the framework of the NECT (New Energy Conversion Technology) program. A contract was signed in 1992 with the burner manufacturer Furigas, which produces central heating boilers for domestic use, for the commercial production of such boilers. In short, companies are welcomed at ECN with their questions on research matters. In this way, Stork Product Engineering took the initiative with the FLEXHAT project, which is for testing a flexible hanging of the rotor blades of windmills in order to appreciably lessen the mechanical stress. ECN is a major partner in this project. Tests with the experimental windmills in Petten provided the proof that such a reduction does indeed take place. Talks are now under way with interested manufacturers for the next phase, the construction and testing of a commercial prototype. Direct orders are also possible: A feasibility study has been set up for the Amsterdam Energy Company to look into the possibilities of adapting natural gas as a motor fuel for company vehicles in Amsterdam.

Industrial Advisory Council

According to Van den Kroonenberg, ECN is giving priority to cooperation with industry. Not for nothing has 1993 been declared the Year of Industry. In concrete terms this has led to the setting up of an Industrial Advisory Council (AC) in which not only large industrial energy users, but also the producers of energy equipment have a seat. Other research institutes are also represented. The board will advise ECN on relations between ECN and industry. This industrial enthusiasm has been triggered by Van den Kroonenberg's conviction that the present malaise in technology development can only disappear when there is interaction between the Netherlands research community and the market place. "Now it is too often the case that a university announces that it is developing something marvelous, whereas they should extract ideas from the market and transmit them for further development to Large Technical Institutes (GTI's) such as ECN, which, in turn, could consult universities should any fundamental questions arise." For Mr. van den Kroonenberg, a good example of how matters should ideally be is the working procedure followed in the research and development of the fuel cell. The cluster consisting of ECN, Stork, and Schelde, which was formed within the framework of the Ministry of Economic Affairs' "cluster" policy, is operating perfectly, and he feels there should be more of such clusters of companies. Still, Van den Kroonenberg has observed

that, despite the negative image that the technology has in the Netherlands, in the energy sector there is a marked drift toward renewability: Both in the construction of coal gas burners and fuel cells and in work on solar cells, the Netherlands occupies a leading position. The situation is not, therefore, hopeless. "And exactly in times of recession," as Van den Kroonenberg puts it, "...it is important not to neglect anything from which you can benefit in the future. The challenge for every company on the way to a renewable society is the critical research into the use of energy and raw materials. Continue to innovate and keep coming up with new ideas," goes on the message from Van den Kroonenberg to the Netherlands business world. ECN is ready to conduct the research into these new ideas.

ECN Organization

In total ECN has more than 950 people working on energy-oriented research. In 1992 they were together responsible for a budget of 152.4 million Dutch guilders. Forty percent of this amount came directly from the government. The research is split among five business units, each of which is responsible for the acquisition and execution of its own assignments. The largest of the business units are ECN Fossil Fuels and ECN Nuclear Energy, while the fastest growing are ECN Renewable Energy and ECN Policy Studies. The fifth and last business unit is ECN Radiation Technology. The service units of ECN Technology and General Services provide support on contract to the business units in the form of technical and infrastructural services. However, as of 1 January 1994, the ECN Technology service unit will be turned into a business unit and renamed "ECN Engineering." Market partners can then go straight to this unit, in particular for consultancy services in the field of the appropriate use of energy and materials.

European Affairs: EUREKA Coordinates Solar Energy Research Projects

BR2210114193 Amsterdam RESEARCH PLUS
RESULTS in Dutch Sep 93 pp 32

[Article by Bas Pulles: "EUREKA Eurovoltaic: Consolidation of European Expertise for Cheap Electricity from Sunlight"]

[Text] Sunlight is free, inexhaustible, directly available, and environmentally friendly, an ideal source of energy. The turning of sunlight into electricity requires, however, an advanced technology. Electricity from sunlight is at the moment, therefore, still significantly more expensive than that obtained from conventional sources.

But the global market for photovoltaic (PV) systems is promising; it is estimated at about 825 million Dutch guilders. The expectation is that, by the middle of the 1990's, this will have doubled. R&D efforts being put into the field of PV technology by European companies have also grown tremendously in the last few years. Investment has increased by around 35 percent.

EUREKA

This fact can be observed in the EUREKA [European Research Coordination Agency] program, which now includes six cooperative projects. One of them focuses on the use of a large number of mirrors for the collection of solar energy. The other projects are directed toward various aspects of photovoltaic techniques and applications of PV systems.

In order to combine the powers of the European companies and to prevent overlapping in research programs, the umbrella project "Eurovoltaic" has been created. Within the scope of Eurovoltaic, industry-oriented projects in the field of research, development, and application of PV technology are launched and coordinated. The project began in May 1992. In the meantime, 23 institutions and companies from 16 different countries, together with the European Commission, have joined in. Siemens Solar GmbH is leading the project. The initiative for Eurovoltaic came from Germany. This is not so surprising, since Germany is one of the few countries which developed its own industrial capacity in the full range of PV technologies: from manufacturers of PV modules and components via installers and the electricity companies to maintenance engineers. In short, a strong basis for the export to Third World countries, which in the near future will constitute the major consumer markets.

For several years, the German Government has been investing considerable amounts in the establishment of an infrastructure for the PV industry. In the 1982-1992 period, the PV industry in Germany was supported with almost 800 million German marks. Both basic research and demonstration projects in the field of PV technology received subsidies.

The Netherlands, which has been linked to the initiative for only a short time, is represented within Eurovoltaic by NOVEM [Netherlands Association of Energy and the Environment] and SENTER [government agency managing Ministry of Economic Affairs projects]. Companies which are interested in activities within Eurovoltaic can ask them for information. "Eurovoltaic offers the Netherlands business community a broad platform for making the necessary European contacts, by which more and better collaboration projects become possible," stated Mr. ter Horst, program manager for photovoltaic solar energy at NOVEM.

Topics

Important topics within Eurovoltaic are research into new materials for photovoltaic cells, development of components and complete systems, and research into new applications for solar cells. The most important topic involves combined research into new and more efficient production methods. By cutting the production costs of solar cells and increasing their energy conversion rate (at the moment, only 14 percent of the available energy is turned into electricity), this technology will eventually be able to compete with the present forms of

electricity generation. This will give rise to a large number of new applications for PV technology. "The expertise is certainly available in Europe, but it is now time to utilize it more efficiently so as to further improve Europe's leading position in the field," claims Dr. Aulich of Siemens Solar.

FACTORY AUTOMATION, ROBOTICS

Problems of German Machine Tool Industry Analyzed

93W50703A Duesseldorf *HANDELSBLATT* in German
1 Sep 93 p 2

[Article by Karlheinz Voss: "Dangling Precariously" [Subheadline: "Machine Tool Industry in Deep Crisis"]]

[Text] The fate of the German machine tool industry's large volume suppliers is hanging by a thread. Their financial situation is catastrophic. The market has completely bottomed out. The period of horrendous losses continues on. Companies have been pared to the bone. Assisted by banks, share owners, employees and even the government, all concomitant measures risk turning into scrap paper.

Cuts in capital, increases in capital, forgoing bank debts, forgoing of employee wages, state sureties, government credits and government ownership of stock: nothing was overlooked. Companies are endeavoring to counter with all means available: cost management, adjustments in capacity, plant closings, cooperative activities, strategic alliances and mergers. But the market has dwindled faster than the measures can take effect. The most important manufacturers of lathes or milling machinery produced in large lots - Dekkel, Maho, Gildemeister or Traub - have hardly any air left to breathe.

It is difficult to conceive the extent to which orders have dropped. In 1992 incoming orders for the sector were still at only about 60 percent of the volume for 1990. In the first six months of 1993 orders declined again by nearly 40 percent. German manufacturers would be left with only about a third of their business in 1990 if this trend were to continue. Not only does the sector have to shoulder the sharpest and lengthiest collapse since the end of the last war, but the extent of the decline in demand also might be the largest that a sector has ever had to confront in "normal times."

Position Could Still Be Consolidated

In this situation the Germans have not at all had worse sales than the foreign competition. First, there are the Japanese, who still remained the world's largest producers of machine tools with a 1992 share of 25.1 (27.1) percent. At 22.7 (20.6) percent Germany meanwhile was able to consolidate its number two position. The U.S. comes in third distinctly at a distance (9.2 percent).

German firms failed to get their cost structures under control in the earlier good years and that is why their existence is seriously threatened and why they are still economically worse off than the Japanese competition that also was impacted. Before the current crisis, among large volume producers, job productivity benchmarks in Japan were more than twice as high as in Germany. That can be explained primarily by greater capital intensity, more flexible use of the labor force and more favorable structures of companies with greater volumes in Japan. One study verifies that per hour labor costs alone in Japan are 32 percent lower than in Germany.

Market Recovery a Long Way Off

Given the press of time, therefore, it is the job of German manufacturers, first, to lower excessively high structural costs, by 30 percent, as a rough estimate. Next, they again practically have to reduce a cost level that has become much too high through a halving of business. Over the short term, however, that is possible only conditionally. The time pressure keeps on growing.

Even though a market recovery is not foreseeable, it still would have to at least stabilize somewhat, so that the producer can survive from hand to mouth at least until demand picks up. If orders remain weak, machine builders allegedly can barely hold out for more than two months with their current resources. Hence, renewed support from outside will be urgently required. Otherwise the potential prospects for the medium-size sector can be conjured up in only the gloomiest colors. The loss can hardly be projected.

Although the machine tool industry only has limited direct economic significance, it still occupies a key industrial position. In the technology chain its position consists of the fact that without machine tools no production machinery and therefore no end products can be manufactured. Losses of position over the long term would also undermine Germany's strong position in the applied sectors of machine building and the automobile industry.

The importance of the machine tool industry for metal working resembles that of semi-conductor production equipment for chip producers and the electronics industry. Europe has already lost the battle in the latter field.

Germany: European Machine-Tool Exposition Reported

93WS0726A Duesseldorf VDI NACHRICHTEN
in German 17 Sep 93 p 16

[Article by Kaem: "Machine-Tool Industry Wants to Get Out of Crisis; Industry Shows Itself to Be Technologically Fit at EMO in Hanover"]

[Text] Hanover—The Machine-Tool Exposition (EMO) is being held in Hanover in an economically unfavorable environment from 14 to 20 September. Two thousand firms from 37 countries are displaying their products at

this "Exposition Europeenne de la Machine-Outil" [European Machine-Tool Exposition] without much hope for receiving orders.

All signs point to streamlining in the traditional industrial countries. "Extensive investments are necessary." Sepp D. Heckmann of the board of directors of German Trade Fair, Inc., in Hanover even regards the machine-tool industry as the "royal branch" of the mechanical engineering industry.

But recovery tendencies cannot be counted on in the short run. Buyers of machine tools and tools, control devices, and other production equipment are too deeply buried in the trough of the economic situation. This is why machine-tool production declined worldwide by \$8 billion as early as 1992—by 20 percent as compared with 1992. The Japanese were hit the hardest with a drop of 30 percent. During the first half of 1993 production in Western Europe even declined by 40 percent again as compared with the same period last year.

The chief capital goods industry trade fairs are always a sensitive barometer in such difficult economic situations. Positive or negative expectations are multiplied for all the participants. But even if the economic situation should attract the purchasing industries again, slight hopes exist for even the next EMO in Milan from 4 to 19 May 1995. Because, if there is an upturn in the economy, machine-tool users will make full use of their existing plant equipment first.

Machine-tool manufacturers have always suffered during these shifting economic cycles. When a downturn is imminent in the industry, orders for new plant equipment are halted early on—and when there is an upturn again, investments for expansion are only set in motion when the degree of full capacity utilization is visibly exceeded.

At any rate, there are special reasons why 90 percent of the worldwide offering in metal-processing equipment can only cope with the recession and prepare themselves for a future upturn with intelligent production." Hans-Juergen Marczinski, the chief commissioner of the Hanover EMO and chairman of the board of the exposition committee of the German Machine-Tool Manufacturers Association (VDW). What is important for the users is to obtain a comprehensive and accurate overall picture of the situation.

At this point, halfway through the world's biggest machine-tool exposition, it is already clear that nowhere near the record number of visitors to the last Hanover EMO in 1989 will be attained. But this has not kept the exhibitors from offering innovations the likes of which were unnecessary in better times for making sales. The machine-tool industry is determined to emerge from the crisis strengthened not weakened.

"What keeps us production technicians going are market and customer demands for our products." Hans-Juergen Marczinski also emphasized during the inauguration of

the EMO on 14 September. "When the locomotive of the economy had a full head of steam, everything had to be better, more specific, and more complex." But now the primacy of what makes economic sense has priority over technologically possible and cost-effective solutions. Marczynski had this to say about trends at the EMO: "The word is: As good as is necessary, but not as good as is possible."

Firms Present CNC Machines

93WS0726B Duesseldorf VDI NACHRICHTEN
in German 17 Sep 93 p 16

[Article by KuK: "Lathes Geared to People: Handwheel Returns Electronically; Turning Point at EMO: Skilled Worker Helps Run Equipment Again"]

[Text] Hanover—Fanuc is currently producing 50 controls for the "electronic handwheel" in Japan. The West German firm, Keller Didactics+Technology, cannot yet list such items with its "CNC [computer numeric control] plus" machine. Moreover, there is an East German consortium in the business that is also currently displaying its products at the EMO [Machine-Tool Exposition] in Hanover.

Who would have thought it? The handwheel is back. Many a lathe operator's heart would have leapt for joy had his spirits not been depressed by early retirement. Because CNC has been "in" these past few years. Those who could not keep pace dropped out of the race. But now something new is looming on the horizon.

Unlike the CIM [computer-integrated manufacturing] designs of the 1980's, in which the emphasis was on technology and the skilled worker played a more or less subordinate role, designs for CNC machines are being exhibited at EMO 93 in which the skilled worker is the center of attention. While the Keller Company is displaying its "CNC plus" in Hall 19, the firms, Cenith Control, Schwerin, and Augustin & Partner of Neubrandenburg, are exhibiting their recently developed "Mec 2" lathe at the same stand as Rohde and Company's Mecklenburg Development Company in Hall 21. It processes workpieces in the conventional way as well as on the basis of CNC.

"While manufacturing companies want to buy inexpensive machines with a wide range of production applications, many manufacturers have been distancing themselves more and more from the small and medium-sized businesses," Siegmund Augustin, the managing director of Augustin & Partner, explained to visitors to his stand at the EMO. He said that there are too many very expensive and specialized machines as well as machine systems that are often hard to operate. The German mechanical engineering industry has been gambling too long on the effort to achieve what is technologically feasible. Overly expensive, fancy machines are getting to be more and more unaffordable.

Up to now, operator training courses lasting several weeks at the manufacturer's facility have often been absolutely necessary for the complex machine systems. "And even after expensive training, operators often master only 80 percent of the performance potential of a machine after from four to eight months," Siegmund Augustin said to VDI NACHRICHTEN. "Costly operator training courses and highly-paid experts are increasingly more often unaffordable for small and medium-sized companies," Roland Rohde, the managing director of Cenith Control in Schwerin, added.

As against this trend, the East German newcomers want to take the path of operator friendliness with the new lathe. "We're counting on the fact that even less qualified skilled workers can learn how to operate the lathe in from four to six weeks on the job," Rohde thought, and went on to say: "We think it important for the 'turning' process to be clear and simple, from the outfitting of the machine to its controls."

Anyone who is wary of the trend indicated by the German firms at the EMO can visit Hall 8 of the fairgrounds. There the world's biggest manufacturer of CNC control systems, Fanuc, is displaying its "20 Series," and "electronic handwheel." According to Japanese president of Fanuc Seiemon Inaba—at the trade fair on 14 September—they are trying to achieve a monthly production figure of 100 machines. Many Japanese manufacturing companies are currently experimenting with this technology. What is involved is the replacement of conventional machine tools with inexpensive CNC's.

With this machine the skilled worker's competence is utilized without relinquishing the logic of the microprocessor. All the steps required in processing by handwheel are graphically displayed on the monitor. With this machine the operator can at any given time switch to the other kind of control system.

Repair Technology Uses CO2 Lasers

93WS0726C Duesseldorf VDI NACHRICHTEN
in German 17 Sep 93 p 16

[Article by Kaem: "Meeting of Mold Manufacturers at EMO: Laser of Help in Milling and Coating: Temperature-Resistant and Hard Materials Can Be Worked More Easily"]

[Text] Hanover—The wear and tear on costly tools and components of machine-tool and manufacturing-plant equipment produces material losses amounting to over DM30 billion a year in the Federal Republic of Germany. The Fraunhofer Institute for Production Technology (IPT) in Aachen is currently demonstrating new ideas for repairing them at the EMO [Machine-Tool Exposition] in Hanover.

The sparks were flying at the Swiss Rigid Milling Machines Company stand: The Aachen firm, IPT, supported by Trumpf Laser Technology, Inc., of Ditzingen,

was demonstrating combined milling and laser-beam processing at the 10th EMO. Engineer Adam Zaboblicki explained the equipment configuration on display there: "We outfitted a conventional Rigid Milling Machines NF-200 milling machine with a 6-kW CO₂ laser made by Trumpf." In addition to using the laser to help erode the material (milling), highly wear-resistant coatings composed of hard alloys—stellite, for example—could be applied with the laser beam.

The following results are produced—as can be seen in Hall 13—when repairing reshaping tools: identification of worn surface areas, removal of worn areas on the edges of the material, filling-in of eroded surface volumes, production of the required work surfaces. "With this system, both laser-assisted milling and conventional milling go into action," IPT specialist Adam Zaboblicki pointed out.

Machining is problematic, basically because of the specific material properties of the nickel and cobalt alloys (Inconel and stellite, for example). The high resistance to heat and the low thermal conductivity as well as the hard carbides contained in the structure led to a heavy thermomechanical strain on the cutting edge of the tool. This is why the IPT sees a very promising alternative in thermal machining. The area of the workpiece that is to be machined and which is directly in front of the milling tool is heated to such an extent by the external heat supply with the aid of a laser beam that its solidity and hardness are reduced in the shearing area and a plasticization occurs which clearly improves its machinability. "It results in a significant reduction of machining forces, by more than 60 percent, and of tool wear, by over 90 percent," Zaboblicki emphasized.

The laser also helps in applying the material: In powder form, the materials are brought into the focal point of the beam. In comparison with coating technologies like application welding, this results in an especially precisely controllable process as far as accurate application of the material is concerned, a high coating quality (degree of mixture < 5%), and less thermal influence from the substratum material. Adam Zaboblicki emphasized during his presentation of IPT developments.

The combination of two processes considerably prolongs the life of costly tools. A forge die is repaired by coating it with a laser beam and then machining it thermally with the assistance of a laser, as can be seen in Hall 13 of the EMO.

European Industrial Policy Proposed

93WS0726C Duesseldorf VDI NACHRICHTEN
in German 17 Sep 93 p. 1

[Article by Siegfried Kaempfer: "Voices From EMO Machine-Tool Exposition in Hanover: It Pays to Nail One's Colors to Mast Despite Recession; Stiffening Competition Boosts Awareness of Technology; European Manufacturer and Umbrella Organization CECIMO, Proposes Coherent Industrial Policy to EC"]

[Text] Hanover—The emergency situation persists. And there are even advantages in connection with it. Since a key industry is remembering its strengths. This is why a defiant confidence is dominating the Machine-Tool Exposition (EMO) being held from 14 to 22 September. The only question is: When is the upturn coming? Experiences with economic cycles speak in favor of 1995.

The long-established EMO has burst into the social policy discussion on Germany's standing in the industry at just the right moment. Since in this industry it can be shown in an exemplary manner what is lacking in this high-tech industry in terms of capital goods manufacturers' promotion or simple salesmanship.

The Federal German machine-tool industry has gladly adorned itself with the figure that its sales volume represents, only 0.5 percent of the gross national product. But this understatement seems to be somewhat artificial, even at the EMO in Hanover, since the visitors know perfectly well that they can familiarize themselves here with the means of production that will help to ensure their future corporate profits.

"The pressure to produce in a cost-effective manner is always greater precisely in times of a weak economic situation," Hans-Juergen Marczinski, chief commissioner of the EMO in Hanover and chairman of the Association of German Machine-Tool Manufacturers (VDW) exposition committee in Frankfurt, also knows.

Dieter Weidemann, chairman of the board of Pittler, is gambling on technological competence in Hanover. "We're going to further improve the productivity of machines and plants." And Seuemon Inabal, the head of the uncontested leader of the CNC market, Fanuc, is, of course, setting his sights on the user when he puts forward the triangular pillar of the Fanuc philosophy: "high quality, high performance, low price."

But relating closely to the market does not help much if the demand is lacking. According to Werner P. Rieben, the president of GE FanucAutomation in Europe, the new plant built in Luxembourg in 1991 for CNC's and memory programmable controls has still not gone into operation because it is cheaper to supply Europe from Japan and the United States. Fanuc and General Electric, the parent companies of Joint Ventures GE Fanuc, which operates worldwide, have their home bases there. As far back as seven years ago, they had formed a strategic alliance which is now a model for European ambitions.

In any event, at the inauguration of the 10th EMO on 14 September, the president of CECIMO (European Committee for Machine-Tool Cooperation), Yves de Boisfleury, came out in favor of concluding cooperation agreements between Europeans in order to emerge from the economic crisis better organized and hardened. CECIMO would like to see a coherent industrial policy.

with a promising future at the European level. But: "We're against protectionism," Yves de Boisfleury emphasized.

The president of CECIMO appealed to the political and social partners of the machine-tool industry to preserve the industry's competitiveness. "Europe is at a considerable disadvantage as concerns the social costs—in comparison with the United States and Japan too."

This is why CECIMO has sent the EC Commission a position paper, in which seven elements of a policy for the industry are described which the organization feels are necessary to ensure the survival of the crisis-racked industry and "to permanently correct the notable imbalance between Europe, Japan, and the United States."

Yves de Boisfleury, president of CECIMO at the inauguration of the EMO on 14 September in Hanover: "Industrialists should make use of this occasion to conclude cooperation agreements between Europeans."

Fanuc of Japan is a world market leader in the field of CNC controls. For the head of the firm, Seiemon Inaba, it is clear that: "We are aware that many European users are gambling on the trend toward open controls. But the key to the CNC of the future lies in the drive unit."

Standards are being raised: "Along with reduction of costs and assurance of quality, compatibility with the environment will be a primary factor in competition." This is how Prof. Wilfried Koenig, an Aachen university professor and head of the Fraunhofer Institute for Production Technology, sees the situation.

As chairman of the VDW exposition committee, Hans-Juergen Marczinski takes a confident view of the situation: "The turnout this year is an impressive signal for self-assertion in the market and for confidence in the economy's recovery from the present slack period."

For Tyll Necker, the president of the Federal Association of German Industry (BDI), who opened the EMO in Hanover, the internal European market is a reality. "With it, the competition for position in the market has considerably intensified."

Prof. Dieter Weidemann, chairman of the board of the Pittler Machine Works, sees a silver lining on the horizon: "Our strength must lie in the most economical processing of high-quality production components. This way we'll have a good chance of succeeding," he said at the trade fair in Hanover.

German Industry Reviewed

93WS0726E Duesseldorf VDI NACHRICHTEN
in German 17 Sep 93 p 18

[Article by Kaem: "Chief Metal-Processing Trade Fair Wants to Convince Buyers With Innovations; Economic Downturn Must Be Ended; Machine-Tool Manufacturers Association, VDW, Reports Slight Increase in Full Capacity Production by Firms"]

[Text] Hanover—The Machine-Tool Exposition (EMO) in Hanover will be closing its doors in the middle of next week. Has it produced the impetus that the industry expected it would? At least one sign that it has is that full capacity production by these German capital goods manufacturers has increased: Production was 71 percent of full capacity in the first quarter of 1993 and it is now at least 75 percent.

In any case, advantageous for the visitor to the EMO is the fact that: During the sales crisis that has persisted for two years now, firms have speeded up developments with which they hope to succeed in a market that has become more limited.

But the EMO has not produced the final determination as to whether the hitherto most serious of all of the postwar crises is coming to an end. Specifically, a trade fair at which sales are made is not under any circumstances what is taking place in the nine days between 14 and 22 September. It is, of course, a question of "psychology," but that has always ended at people's wallets, no matter how concerned about it they may be.

That pressure to invest exists is clear to manufacturers as it is to users of efficiency methods. Therefore, hopes for an improvement in the sales situation depend above all on the requirements of the automobile industry and the mechanical engineering industry that supplies it.

As is now being discussed at the EMO, there are at least a few positive signs in foreign trade: The Federal German Association of Machine-Tool Manufacturers (VDW) has announced that the CIS [Commonwealth of Independent States] reported back with a few big orders and that trade with the United States is developing in a positive way. The VDW said, however, that, since they are facing a decline in demand in Europe, foreign orders would on the whole still amount to not quite a third less than last year's volume.

The number of orders received during the first few months of 1993 was by and large 35 percent less than the equivalent volume last year. By the middle of the year the gap was 38 percent. The industry anticipates a drop in orders of about 20 percent for the whole year. This means that the crisis is continuing. And the question being raised in all the discussions at the EMO as to whether such economic developments can be met with technology. At any rate, the attempt is being made—be it with machines that clearly perform better than they have up to now or with "leaner" versions that also technologically fit in with the effort to achieve lean production.

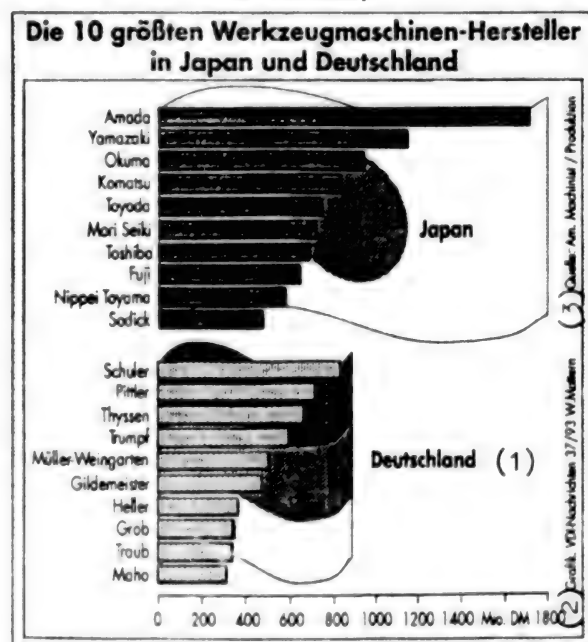
There is no shortage of innovations at the EMO: The fact that Pittler is entering virgin territory with a vertical rotary center may still be viewed as a "rounding off," even though there are offers enough on the market. Things look the same at the vertical processing centers: Kaum is merging with Maho and Deckel is pulling a number of recently developed vertical processing centers out of its hat. Michael Geiger, the managing director of Deckel's technology division, said: "Conducted as an

independent project, the DC-V construction series came into being with the specific participation of Deckel customers." All three of the new vertical centers are equipped with the new, easy-to-operate Grundig Dialogue 110 controls and a digital drive technology.

The fact that it is no longer only the mechanical tool that is involved, but the microelectronically imprinted environment it is in, is also demonstrated at the CIM [computer-integrated manufacturing] Cneter in Aachen with its "neutral exchange format for tools." As managing director Peter Kettner explains at the trade fair, activities that are for the first time being jointly undertaken by competitors are raising a clear signal for more customer service. The tool manufacturers, Hertel, Krupp Widia, Sandvik, and Plansee, are each exhibiting systems at their EMO stands.

Last year the setbacks in sales volume were more serious

The 10 Biggest Machine-Tool Manufacturers in Japan and Germany



Key: 1. Germany. 2. Graphic: VDI NACHRICHTEN N 37/93 W. Mattern. 3. Source: AM. MACHINIST/PRODUCTION.

for the Japanese manufacturers than for the Germans. Nevertheless, nothing has changed in the order of rank: The competition from the Far East is greater due to sheer size. But a new path is being pursued in Germany too through mergers and cooperative sales arrangements.

German Manufacturers Enhance Cooperation

93WS0726F Duesseldorf VDI NACHRICHTEN
in German 17 Sep 93 p 1

[Article: "Machine World: Heard and Seen at EMO '93"]

[Text] The Cologne firm, Alfred H. Schuette, has been vigorously promoting the constructive development of its multispindle rotary robots. The results can be seen in Hanover. The unusual feature of the new type of machine: The bed is made of a mineral casting. At Schuette they stressed the fact that the use of this material is a trailblazing step. Great static and thermal stability as well as extraordinary cushioning qualities are the special characteristics. The spindle carrier module was completely reworked. Three-part spur-gear meshing rings to lock the spindle cylinders into position and other constructive measures are designed to increase the positioning accuracy of the cylinders as well as the tool carriage. The machine on display is designed for a maximal rod diameter of 32 mm and permits spindle revolutions of up to 4,000 min⁻¹.

Representative of the cadnology series, the new Elb CAD [computer-aided design] Master is being exhibited, a machine built completely on the computer screen. This flat and contour grinding machine made by El Cut in Babenhausen is capable of tracking in all axes and is notable because of its worktable, which can be rotated 180°, with two locking stations. The operating motion is carried out completely by the grinding column, which performs in two axes (X, Z). The Elb Cut experts in Hanover pointed out that loading the machine with workpieces while it is grinding on the opposite side is a demonstration of the high-performance capability of the machine.

In the opinion of its exhibitors, the new T-130 processing center from the cross-table machine program of the Gera, Ltd., Union Machine-Tool plant meets especially high standards of milling performance, accuracy, reliability, and universal operational range. The machine is equipped with a Heidenhain TNC-425 control and a digitalized drive technology. The mounting table measures 1,600 mm x 2,000 mm with a table load of 8,000 kg. Gera production specialists in Hanover said that the 50-kW power output, a main spindle speed of 3,000 revolutions/min⁻¹, and a spindle-transmitted coolant supply enable the operator to use the most up-to-date tools. The machine has a remote-controlled diagnosis-maintenance interface which makes it possible to transmit NC [numerical control] programs. A tool changer with a chain magazine for 60 tool slots is in keeping with the high degree of automation.

The takeover of the whole Norte vertical processing center program by the Fritz Werner Machine-Tool Company of Berlin followed its development into a universal, vertical modular system. The three-spindle VMT-L4 vertical processing center is a product of the development of the VS-800 single-spindle center and the VSD-802 two-spindle center. This system with a stationary mounting table has two separate work areas. Since it operates like a pendulum, workpieces are loaded and unloaded without stopping the machine. Since each of the three spindle cases can be operated separately, it is not necessary to use three identical tool sets. This reduces the cost of tools, tool preadjustment costs, and

assembly and outfitting time for changing tools and jigs. Every spindle case has a chain magazine with 40 or 60 tool slots that is completely isolated from chips, shavings, and coolant. It takes 5.8 seconds to shape a workpiece.

Technologies Exhibited

92WS0726G Duesseldorf VDI NACHRICHTEN
in German 17 Sep 93 p 18

[Article by Dietmar Kippels: "Machine-Tool Manufacturers Betting On Cooperation; Comprehensive Cooperation Between Firms Lowers Development and Production Costs"]

[Text] Duesseldorf—German machine-tool manufacturers are facing far-reaching organizational and technological changes if they want to protect their international top rating in future. A study conducted by the BBE [Trade Consultation Office for the Retail (Rade), Ltd., in Cologne comes to this conclusion: "Many management errors were made in the past, during the boom years, errors that could be concealed because of the continuous boom," Klaus Peter Teipel, a BBE expert on the industry, emphasized.

Prof. Guenter Spur, the director of the Production Technology Center in Berlin, ascertained that one of the "chief sins" of the past was in German supplier's cost structure: "Now it's clear that the position in the market attained up to now by the local machine-tool industry is in jeopardy because of its high prices." According to what he said, efforts have to be made here. "Especially as concerns standard machines, being able to offer competitive prices is still an indispensable prerequisite." Furthermore, in Guenter Spur's opinion, many firms are incapable of promoting new, relatively short-term product technologies that closely relate to the market. "New technologies like, for example, laser-assisted production, the use of new materials, and the development of automation systems are examples of current research and development projects, the results of which it pays to transform into innovative products."

German suppliers still retain their international standing despite the recession. Thus in 1992 nearly 48 percent of worldwide machine-tool production, worth just under DM54 billion, came from Japan (25.1 percent) and Germany (22.7 percent)—the only countries that have realized two-figure shares of the market since 1990.

The Association of German Machine-Tool Manufacturers (VDW) in Frankfurt recognized the situation and, together with the consultation firm, Munich Corporate Consultation, has developed a comprehensive strategy paper to protect German manufacturers' competitiveness. "Among other things, it contains ideas for increasing our international market presence with the aim of preservation, that is, recapturing volume markets. In addition, the machine-tool manufacturers consider it essential to improve their own cost situation, which

includes—not least of all—increased cooperation in many areas," VDW president Bernhard Kapp stressed the fact.

And this, the authors of the study of the industry conducted by the BBE in Cologne believe, is also necessary. In the study they point out that Japanese manufacturers, because of the large number of big companies, have access to a fatter finance cushion than the German industry, which is mainly structured in terms of medium-sized companies. Thus the 10 German firms with the largest sales volume attained a combined sales volume of about DM5.1 billion in 1992. The corresponding Japanese group of 10 attained a figure of over DM8.4 billion during the same period. "Because of this, the Japanese can hold out for a substantially longer time than their German competitors in crisis situations," Klaus Peter Teipel said. "Especially in the areas of development and production, costs can clearly be lowered through joint operations."

These insights are gaining ground in the German machine-tool industry. Maho and Deckel, the Bavarian competitor duo, have merged and the firms, Traub and Hermle, based in Wuerttemberg, are cooperating in sales and are exhibiting their products at the world's biggest exposition for metal processing, EMO 93, in Hanover under a common roof at the fair.

Austria: Survey of Industrial Robot Use

Paris PRODUCTIQUE/AFFAIRES in French
20 Sep 93 p 7

[Unsigned article: "Robotics in Austria"]

[Text] Slightly more than 1,500 robots were in service in Austria in 1992, compared to 1,186 of them in 1990 (WIFI survey, DI Heinz Moos). However, the installation of new robots is proceeding at a slower pace. WIFI attributes this slowdown to an economic situation unfavorable to investments, and to delocalization towards neighboring eastern countries, where salaries are lower. Only 17 percent of all robots are installed in enterprises with fewer than 100 employees. According to the Austrian experts, small and medium enterprises are therefore under-equipped, and their demand for various automation devices should increase in coming years. Use of industrial robots in Austria falls in five main groups: welding (21 percent of units), injection or pressure molding of parts (17 percent), assembly (16 percent), and tooling (15 percent). Thirteen percent of the robots are intended for various operations on parts to be machined. Broken down by industrial sectors, electronics and electrical equipment are in first place (32 percent), followed by mechanical construction (19 percent). The sectors with the highest rate of automation are electronics and chemistry. In spite of a recent spurt, automation of enterprises remains weak in Austria compared to other European countries. The ratio is 10 robots installed for every 10,000 workers (compared to 26 for 10,000 in

western Germany). The three main manufacturers supplying the Austrian market are ABB, IGM and Hirata.

Germany: Fraunhofer Develops Laser-Aided Machining Process

MI2610105893 Bonn WISSENSCHAFT
WIRTSCHAFT POLITIK in German 22 Sep 93 p 4

[Text] "Laser-assisted machining constitutes a revolution in production engineering," says Masakazu Matsumoto, president of one of the leading machine tool manufacturers in Japan, referring to a process for machining high-strength metal materials and ceramics developed by the Fraunhofer Institute of Production Engineering (IPT).

The Fraunhofer researchers in Aachen succeed in using laser-assisted hot machining to manufacture complex components, even from aircraft engine alloys and high-strength steels. During processing, a laser beam heats the work piece to the desired temperature, thus lowering the strength of the material to the point where it can be subjected to machining.

High-performance ceramics are an example of how new materials can be used in various ways in different fields, not only in space vehicles and racing cars, but in more mundane, every-day uses as well. For instance, they give all modern faucets a considerably longer service life than their metal predecessors.

Laser-assisted hot machining opens up new prospects closed to conventional machine engineering: For example, complicated geometries in medical engineering, such as bone joints, can be manufactured with precision. Further research work is being undertaken on laser-assisted machining with a view to reducing tool erosion and broadening the base on which new materials can be used in industry and the world of science.

Denmark: DTI Technological Institute Uses Rapid Prototyping

BR0311160993 Oslo NEW SCANDINAVIAN
TECHNOLOGY in English Oct 93 p 28

[Text] Professors at the Royal Dental College in Denmark expect great things from the new technology. It has already helped save time and money in development departments of Danish companies. Its name is Rapid Prototyping.

Rapid Prototyping Technique (RPT) is the collective term for a group of technologies developed since 1986. With RPT, models, prototypes, and short series of highly complex geometries may be produced direct from a 3-D CAD [computer-aided design] system. The subjects can be made in a variety of materials, without the use of tools or fixtures.

In the medical field, these models may be used for purposes such as preparing for an operation or making a tailor-made artificial hip.

"We recently produced a model of a child's deformed jaw for the Copenhagen Dental College. This model was based on X-ray scanning data, using stereo lithography (SLA), one of the technologies in Rapid Prototyping," explains Karsten Lumbye Jensen, B.Eng., DTI [Danish Technological Institute]/Industrial Technology.

He continues: "The efforts of the Royal Dental College are primarily concerned with deformities. The models are used, for example, in preparatory work aimed at achieving the best possible results from surgery."

The Danish Technological Institute is currently strengthening its collaboration with the health sector. It is anticipated that, over the next few years, new applications for SLA will become available, both in connection with implantations and for patients suffering compound fractures.

Time Is Money

Otherwise, RPT is first and foremost used in industry. The technology originated in the United States, where a number of leading manufacturing companies have been using it very successfully in their development work.

In Denmark, too, RPT—in the form of stereo lithography—has been adopted by industry. So far around 100 Danish companies have successfully availed themselves of DTI's expertise and SLA equipment for troubleshooting, concept testing, and production preparation, with the aim of reducing throughput times.

Time is of ever-increasing importance for the competitiveness of the individual company, partly due to the ever shorter service life of products. Therefore, it is essential for the company to get its product into the market as quickly as possible.

"It turns out that by halving development time—which is not unrealistic with RPT—you can increase your profits considerably, in some cases by over 30 percent," says Karsten Lumbye.

RPT not only reduces development times, but also development costs. According to Karsten Lumbye, this is due to the fact that, by using RPT, the company obtains a sound basis for its decisions at a very early stage of the development process. There's no mistaking a model in your hand—any construction faults will be only too obvious.

As already mentioned, Rapid Prototyping has been known since 1986, and the technology has been commercially available since 1987. New developments in this field take place in the United States, above all, but Europe, Japan, and Israel are catching up fast. Consequently, there are now many different systems of Rapid Prototyping in existence.

Common to all the systems is the fact that they build their models in layers.

In plain language, this means that the system will take a 3-D CAD model and cut into thin slices. In some systems, the model is built in one piece from the bottom up, each layer being placed directly on top of the previous one. Other systems make each layer separately, assembling them at the end.

As of now, DTI owns the only piece of RPT equipment in Denmark: an SLA machine almost exclusively used for making models for development departments of Danish companies.

LASERS, SENSORS, OPTICS

Germany: High-Precision Measuring System Developed

93WS0638A Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 19 Jul 93 p 10

[Text]

Wavefront Reveals Laser Defects

High-Precision Measuring System from Zeiss Makes Special Corrections Possible

Every light ray can be understood physically as a wave. Zeiss is now making use of this for monitoring the operation of laser systems. The waves form a wavefront which can reveal, for example, inaccuracies or errors in optical systems through changes in focusing. Their exact detection is then the prerequisite for necessary corrections.

The firm of Carl Zeiss, Oberkochen, has now developed a high-precision measuring system with which all changes in the wavefront can be detected very accurately. The wavefront sensor Detect 16 is primarily intended for measurement and correction of laser beam quality in various laser systems. However, it also allows precise quality control of other optical instruments and components in the manufacturing process.

The concept of the wavefront sensor is based on the fact that the laser beam of a so-called plane light wave passes through a well defined group of very small microlenses in the direction of its optical axis. In the focal plane of this microlens array, a characteristic pattern of light spots is produced by the light ray being studied.

In the process, phase errors in the light ray produce corresponding displacements of the spots in this light spot pattern and of their overall geometry. This pattern is recorded by the accompanying electronic camera and evaluated in a computer system. In the process, it compares the characteristic patterns of stored error states and can give precise instructions for correcting errors based on the so-called slope of the microarray wavefront.

The individual detectable and correctable errors involve angular movement, defocusing, astigmatism, and spherical aberrations as well as other special defects. Based on precise error analyses, users of the sensor system are then in a position to carry out all corrections. Zeiss supplies the sensor together with a computer system and the necessary software. Error analyses can also be prepared very quickly in real time with the use of a parallel computer, the firm reports.

Germany: Increased Research to Compete With Japan, U. S.

93WS0638B Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 21 Jul 93 p 8

[Text]

Business Neglects Research

Federal Government Fears Disadvantages in Competition with Foreigners

The Federal Government has accused German business of withdrawing more and more from research and thus provoking competitive disadvantages vis a vis Japan and the United States. The new federal research report states that the Federal Republic, as the largest exporter of industrial goods, has lost out in recent years to its principal competitors in the global market precisely in those areas where research and development are being neglected.

Federal Research Minister Paul Krueger figures that in terms of the gross domestic product, expenditures for research and development in Germany have declined markedly over the last three years. Thus in 1989 the research share amounted to 2.87 percent; in 1992, with a total of 80.7 billion German marks [DM], it was only 2.58 percent. Japan, on the other hand, spends 3.04 percent of its gross domestic product for research, and the United States invests 2.78 percent. The lead over other countries is also shrinking, the report continues.

The Federal Government says business is primarily responsible for the decline in research expenditures. The contribution of business to national research expenditures sank noticeably from 62.3 percent (1989) to 58.9 percent last year. "An important reason for this development lies in the declining dynamic of research and development expenditures in the old German states."

With its specialization in more valuable technologies, Germany achieved outstanding foreign trade results in the eighties. However, important markets such as mechanical engineering and automobile manufacturing are experiencing increasing competitive pressure at present. The report goes on to criticize the fact that German industry's research and development is shifting more to those areas which show below average market growth rates.

Krueger admits that the states' research expenditures are limited by the present budget situation. Nevertheless, in the last three years the Federal Government has increased its expenditures for research and development by 27.5 percent from DM14 to DM17.8 billion. The states have also expanded their contribution to the total research budget.

Switzerland: Improved Chip Developed for Faster Communication

93WS0638C Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 21 Jul 93 p 8

[Text]

Vinci Electronic Chip Encrypts Digital Data

6000 Telephone Conversations Per Second or 5000 DIN A4 Pages/Can Be Retrofitted

Scientists and engineers of the Institute for Signal and Information Processing of the Eidgenossische Technische Hochschule (ETH) [Federal Technical School] in Zurich and a Swiss electronics firm in Solothurn have developed a new, extremely powerful electronic circuit for encrypting digital data. The chip can also be used in communications engineering when operating in digital technology or when analog signals must be digitized.

The inventors have named the chip Vinci. It is a large scale integrated circuit. Measuring only 9.9 by 11 millimeters, Vinci can be retrofitted very well in all communications circuits or on circuit boards. Experts consider the circuit to be the best available today for cryptology.

Encrypting 5000 DIN [German Industrial Standard] A4 typewritten pages or 6000 telephone conversations per second, its performance cannot be surpassed by any other similar circuit at present. The chip operates with a clock frequency of 25 megahertz and encrypts or decrypts up to 178 million bits per second.

The IDEA technique (International Data Encryption Algorithm), in general use internationally, is being used as the encryption algorithm. This method also allows encryption of video signals including the accompanying voice frequency signal.

Vinci operates with 215,000 transistors and thus has about twice the computing power of the 286 microprocessor chip from Intel. As a special feature, the circuit has a built-in self-test circuit so that it can always check the correctness and serviceability of encryption and decryption.

This test is scarcely noticed by users because it lasts a total of only 160 microseconds. Thus, it can take place during a transmission without the user's awareness and so provide a certain guarantee for operability and correctness of data.

Vinci will be used primarily in business, in banking and the stock market, and in private telephone networks. It is

also suitable as interfacing circuitry for the transmission of electronic mail and telefax. Following extensive tests, even with extremely powerful computers, those who try to decrypt such messages and data will be left holding only unintelligible and unreadable data.

Users naturally need the chip in both the transmitter and receiver circuits. The enormously high encryption capability also makes it possible to keep pace with the highest data transmission rates generally used today in the kilobit range.

For the time being, the chip can only be produced outside Switzerland, primarily in the United States, because of insufficient manufacturing facilities. Nevertheless, as far as the idea is concerned, it is a Swiss invention, making the Swiss an electronics supplier.

Germany: Silex Project to Improve Satellite Communications

93WS0638D Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 20 Jul 93 p 8

[Text]

Carl Zeiss: Extreme Precision Required for Focusing Optical Signals

What the designers at Carl Zeiss in Oberkochen call an "optical antenna" is in reality a telescope which does not operate in the visible light spectrum but rather in the so-called near infrared. It is part of the Silex telecommunication project of the European Space Agency ESA, which wants to use it to avoid the increasingly limited radio frequency ranges and switch to optical transmission methods. The name Silex stands for "Satellite Interlink Experiment."

This experiment is supposed to test whether communications between satellites can be improved by infrared light and whether in the future satellite networks can be constructed and operated profitably. Zeiss will build two of these telescopes, which handle communications between the Spot 4 photosatellite, flying in a low polar orbit (altitude 500 kilometers), and the Artemis satellite, in a geostationary orbit at an altitude of about 36,000 kilometers: pictures which Spot takes are supposed to be sent immediately to Artemis, which transmits them by satellite radio to the receiver station.

In the transmitting and receiving modes, the Zeiss telescope operates in the infrared between 790 and 860 nanometers. With an outside diameter of 28 centimeters and a barrel length of 39.5 centimeters, it is smaller than the dish-shaped radio frequency antennas used today and, because of the considerably higher transmission capacity of light, more powerful and reliable as well.

A prerequisite, of course, is that suitably small telescopes can be controlled precisely and be able to manage distances of about 45,000 kilometers without excessive losses, given the optically determined beam divergence

of the infrared laser diode. The divergence at this distance is only permitted to increase from an initial 25 centimeters to a maximum of 150 meters. That corresponds to an angle of only 0.1 seconds of arc. Without such precision, data signals modulated upon infrared light can no longer be captured reliably by the receiving telescope.

That demands very high precision and durability in the construction, the sort practiced at present only in laboratory trials. Because of its special mechanical properties, Zeiss is using the glass ceramic zerodur as a the material for the mirror and barrel since it exhibits practically no thermal motion due to its structure. Yet the material is very strong and elastic enough to operate in the region close to earth and withstand the high stresses caused by acceleration at launch and the high noise levels which occur.

Glass ceramic achieves mechanical stability together with high elasticity because it is a polycrystalline material, about 70 percent of which consists of a crystalline phase in a glass matrix.

Light metals or carbon fiber-based composite materials were out of the question because they are subject to great thermal motion or cannot be manufactured as precision components. Therefore, the glass ceramic telescope manages with a modest barrel wall thickness of only 1.9 millimeters. The total weight including mirror and mounting parts is only 8.5 kilograms.

Meanwhile, the first telescope has passed all heat and cold tests in a vacuum under space conditions, including a 143-decibel acoustic test, an acoustic pressure which is about ten times greater than that produced by a jet fighter at take-off.

The optical communication system also includes a ground station, which, however, will be built by Carl Zeiss Jena GmbH complete with telescope and accompanying 12.5-meter observatory dome. The client here was the German Space Agency DARA.

The telescope has a focal length of one meter and, from the viewpoint of optical control engineering, is designed for extremely exact positioning. It allows positioning of less than a microrad as well as fine positioning of less than 0.2 seconds of arc. The ground station will also operate at light wavelengths in the region of 800 nanometers, which is to say in the infrared region. However, precautions have been taken to operate with wavelengths of 1300 to 1500 nanometers as well.

The telescope and observatory dome are controlled with a computer system which was developed by Carl Zeiss, Oberkochen, for the telescope of the Max Planck Institute, Heidelberg, on the Calar Alto near Almeria in southern Spain, 1991, and reworked for the telescope.

According to telecommunications engineers, the utilization of "optical antennas" is an urgent matter because work will begin on the construction of a world-wide

digital telephone network in the second half of the nineties. This cannot possibly be carried out with the required radio frequencies, even if they switch to new, previously unused bands in the gigahertz range.

In addition, they need microwave transmitting and receiving equipment and facilities, which are only available in the initial stages today. Here optical transmission could contribute to considerable cost savings and thus speed up installation. For the 36 to 40 satellites planned so far, the development costs, high at present, could be quite profitable for Zeiss.

Germany: New Applications for Holography Sought

94WS0007A Duesseldorf HANDELSBLATT in German
30 Sep 93 p 8

[Text]

Holography: Exhibition in Design Center NRW to Give Entrepreneurs Stimulus for Possible Applications

Optical Storage Medium Still Used Far Too Little

Holography—still primarily used today as a medium for three-dimensional display by graphic designers and artists—has a technical potential which has been largely undeveloped until now. Holograms—understood as an optical storage medium—could become more important for the production of three-dimensional images in architecture, medical technology, or product development in the future and drastically improve the storage capacity of computers by the end of this decade.

"Holography is more than just an imaging method with perspective," explains Dr. Peter Zec, director of the Design Zentrum Nordrhein Westfalen [Design Center North Rhine Westphalia] in Essen, who has investigated holography technology intensively in the past. Viewed as intelligent optical data memory with which any desired display can be generated and reconstructed, the technique, known for over 50 years, could offer innovative possibilities which need only be put into practice by industry.

Peter Zec sees the holography exhibition he initiated, which was opened yesterday in the Design Center in Essen and continues until November 21, as a challenge to companies to examine holography technology more closely. "We hope that with the presentation of a variety of innovative projects, new stimulus can be given for further applications."

The Dutch Holographic Laboratory in Eindhoven expects a real breakthrough for holography through the development of a new printing technique with which holograms can be produced online from the computer. The scientists are working on transforming three-dimensional graphic images (CAD drawings or images generated from computed tomographs) into holograms in the computer, which can then be printed using a special printer.

There have been similar research projects underway in the Media Lab at M.I.T. in Cambridge (USA) for several years. There they are working on the development of a holographic videodisc with which it should be possible to generate any desired object and any plastic shape in real time as a hologram using a computer. The project is being supported by General Motors. The company hopes to be able to use holography in the future as a three-dimensional graphic display medium in product development.

With a number of CAD models, it is, of course, possible today to view the displayed object from several sides using simulated rotation around several axes, but in certain phases of development this is not enough. As a rule, a real model must then be made, which takes time and is quite expensive. Therefore it would be advantageous if one could design objects in the computer and immediately produce a real three-dimensional representation from them on the screen—i.e. a hologram—which one could simply modify and continue to view in three dimensions.

Another progressive application of holograms is being presented at the exhibition in Essen by the Institut fuer Licht- und Bautechnik [Institute for Lighting and Construction Engineering] at the Fachhochschule Koeln [Cologne Technical College]. The scientists have developed a solar paddle equipped with holographic-optic elements (HOE) and solar cells for shading window surfaces on buildings. The HOEs concentrate the sunlight on nontransparent strips with solar cells which transform the light into energy. A side effect of the concentration: The surfaces of the solar cells can be reduced by half with the same energy yield.

Between these strips the glass is transparent and translucent for diffuse daylight so that the interior areas are sufficiently well lighted. Since the solar paddles can be rotated, the concentrated light can be also focused on the translucent areas so that in winter, when the supply of radiation is low, the light can be directed into the interior of the building.

Holography can also provide important if not exactly pioneering emphasis in the development of new storage techniques. Essentially, this involves the optimization of data storage by linking holography and electronic data processing. The fascinating thing about holographic storage technology is the combination of extremely high packing density on the smallest possible area with extremely high operating speed and absence of defects. Even at a resolution of 1000 line pairs per mm and a format of 5 x 5 cm, the storage of a data set of 2.5 billion bytes is theoretically possible.

With the present status of research and development, holographic memories of this type for PC use will arrive on the market as plug-in modules by the end of the nineties at the earliest. However, use in mainframes is not expected until the beginning of the next decade.

Expert Sees ASICs As Last Chance for Europe's Semiconductor Industry

94WS0007B Dueseldort *HANDELSBLATT in German*
30 Sep 93 p 8

[Text]

Microelectronics/ASICs As Last Chance for European Semiconductor Industry

Manufacturing in Small Flexible Facilities Affordable for Smaller Firms, Too

Europe is lagging behind Japan and the USA in microelectronics. Today memory chips come mostly from Japan, processors from the USA. But with ASICs, application specific integrated circuits, Europe still has a chance, says the retiring president of the Fraunhofer Society, Prof. Dr. Max Syrbe.

Fainthearted whining about Japanese superiority and calls for government subsidies will have little effect on the desolate position of European microelectronics in the future. Instead, business, science, and government should jointly develop strategic goals and put them into action, admonishes Prof. Syrbe at the end of his presidency as head of the Fraunhofer Society.

Syrbe accuses European industry of two strategic errors. It has tried to copy Japanese successes and cling to the mistaken belief that memory modules are the route to complex circuits. For another thing, large companies have tried, from their trailing position, to gain access to technology through international cooperation and also bring out a new generation of chips with four times more packing density every four years. From generation to generation, that required increasingly expensive factories, which cost around \$1.5 billion today, for cheaper and cheaper memory modules.

Growing investments for a product which can only be sold profitably in the first weeks are not only a horror for every controller but also eat away at reserves. After Philips withdrew, only Siemens, in collaboration with IBM, keeps trying to remain in this business. Yet there will certainly not be a new chip manufacturing facility in Germany in the foreseeable future.

Syrbe, in contrast, calls for a different strategy geared to the needs of the small and medium-sized user. In this context, he sees "small and medium-sized business" not as an ideological delimitation, but rather as a characteristic of specialists who work out sophisticated solutions for very concrete problems. It can be a medium-sized company, but also the specialized area of a group of companies which, after the restructuring current today, is no longer kept on a tight rein by the group's central management but rather must earn money on its own in the market, almost like the small businessman next door.

For this one does not need costly experience with memory modules, but rather ever denser packing of chips, increasing integration, which can be developed in the laboratory, as Syrbe knows from projects of the

Fraunhofer Society. Facilities in which memory modules are produced are designed for the manufacture of standardized mass-produced goods, while special series of ASICs need flexible manufacturing with short throughput time. ASIC facilities thus involve flexible automation of design and manufacturing, of CAD tools and production engineering.

Smaller factories, "minifabs," are thus better manufacturing sites for ASICs. The first signs of a new kind of chip manufacturing are already recognizable at the Fraunhofer-Institut fuer Mikroelektronische Schaltungen und Systeme [Fraunhofer Institute for Microelectronic Circuits and Systems] (IMS) in Duisberg. These minifabs mean compact engineering, smaller ultraclean rooms, and comprehensible costs. The medium-sized semiconductor manufacturer "Elmos" GmbH in Dortmund is already producing ASICs economically with this technique.

In the USA, as well, the trend is in this direction: Texas Instruments Inc. has developed an extensive process control method with "Works" (cf. Handelsblatt 154 of 8/12/1993), which has been set up in the first pilot plants as "single wafer fabs" in the USA and recently in Europe as well.

Syrbe sees special opportunities in joining microelectronics and sensor technology with micromechanics to form complete systems. With refined applications for cameras, medical engineering, or airbags, each of which combines intelligence with mechanics, Europe could work out solutions which are quite competitive internationally. The companies would do better with this than to get involved in the memory chip price war. Even in consumer electronics, Europe has a chance if the devices could be put together from a small number of complex components using extensive automation.

With this strategy, Syrbe wants to point out a way in which the Europeans could continue to play a role in the future between the Japanese and the Americans. In fact, a company that tailors its microelectronics to the right customers can even succeed in Europe, as SGS-Thomson Microelectronics N.V. demonstrates. Of course, French and Italian state-owned enterprises footed the bill, but in the coming year SGS-Thomson should realize \$2 billion in sales and \$100 million in profits with their chips. For this purpose, the company has just built a "waferfab" near Grenoble, not a large-scale plant for mass production of memory units but rather a flexible facility costing a modest \$600 million.

And so the "triad" of this world could be profiled in the future: While the Americans continue to succeed in the global market with their processors and are intent on maintaining their lead over the Japanese with more intelligence on the chips, the Europeans are trying hard to develop and produce their chips for the special needs of their customers so that in this way they can participate in the international division of labor.

UK-Netherlands: Improved Photon Detection Reported

94WS00124 Frankfurt am Main FRANKFURTER ZEITUNG: BLICK DURCH DIE WIRTSCHAFT in German No 180 17 Sep 93 p 8

[Article by ?oel., Frankfurt]

[Text]

Efficient New Photon Detector

British and Dutch Institutes Seek New Applications

The European Community Commission (ECC) will finance a joint project of improving photon detectors and thus making possible amplification of very weak light, a project in which British and Dutch research institutes together with individual enterprises will participate. Such photon detection systems are now used in astronomical research for spotting very remote stars or galaxies. The aim of the project is, therefore, further development of existing systems for practical purposes.

The areas of application for improved detectors have not yet been precisely defined. It is however possible, for example, to mount such detectors in special cameras so that weak bioluminescence or autoradiographic processes could be tracked. This, according to information released by the developers, would make feasible tracking and recording the growth of living cells in real time. The ECC supports the development of a complete camera system by providing about 2.2 million dollars, assuming that many new areas of application for this system in science and research will be found.

The present astronomical camera systems feature already a very high luminous sensitivity, which ranges from absolute darkness to the weakest light signals barely perceptible by the human eye. The image resolution is 2048x2048 and thus higher than that attainable with high-resolution television cameras.

The detector functions, in principle, as a residual-light amplifier and operates with a precisely controlled electronically regulated photon flux. In this way it is possible to change and adjust the spatial or temporal resolution (light amplification respectively).

The project management is in the hands of the British Phototek Co. Ltd. (Leonards-on-Sea, East Sussex TN38 9NS, United Kingdom). The premise is that, at the present state of the art, along with improvement and down-sizing of the detectors compact systems including all necessary electronic components can be built.

The British Rutherford-Appleton Research Laboratories will contribute their software knowledge and experience to the integration of complex systems. The Dutch enterprises will develop and produce miniaturized power supplies and microprocessor circuits.

Specialists in the field regard this relatively very costly project of questionable merit, inasmuch as highly sensitive light detectors and amplifier circuits for competitively priced compact nighttime viewing apparatus are also being developed in North American and Japanese research laboratories.

Germany: Infrared-Ultraviolet Laser Improves Microscope Resolution

94WS0012C Frankfurt am Main FRANKFURTER ZEITUNG: BLICK DURCH DIE WIRTSCHAFT in German No 180, 17 Sep 93 p 8

[Article by Scha., Frankfurt]

[Text]

Lasers Work Like "Knife and Fork"

Zeiss: Combining Infrared and Ultraviolet Laser Offers New Applications

Zeiss in Jena has combined infrared and ultraviolet lasers in a new laser microscope. For handling biological cells one can now use the infrared laser as a "fork" for holding down and the ultraviolet laser as a "knife" for cutting. This is pointed out in the March 1993 issue of the "Zeiss Information with Jena Panorama" company journal.

With such a laser microscope, it says further, the goal of fusing individual animal cells or plant cells has thus now been reached. In plant breeding research one could in this simple and quick way bring together all genetic information from the original cells into a single cell, for the purpose of combining the beneficial characteristics of parent cells (e.g., viral immunity) in the nascent daughter cell and thus in a new plant generation.

Combination of two infrared lasers and one ultraviolet laser for artificial insemination (in vitro fertilization) in animal breeding research indicates possible future applications: this technique being said to make possible contactless gentle and noninvasive handling of sperms and egg cells, also of embryos and other tissues under virtually natural conditions. Fewer intermediate steps are, moreover, required here.

A laser operating at any wavelength can now be adapted for this without any problem, it says further. The hardware technology for coupling two or three laser light sources is being conceptualized and tested, jointly with other German research teams.

MICROELECTRONICS

Thomson's New Integrated Circuit in Grenoble Described

93WS0703B Duesseldorf HANDELSBLATT in German 7 Sep 93 p 18

[Article: "New Chip Plant"]

[Text] Crolles, 6 Sep (HANDELSBLATT)—SGS Thomson N.V., Paris, and Agrate (Italy), will be able to bring submicron-engineering more quickly onto the market and thereby realize better prices as a result of their new chip plant in Crolles near Grenoble.

A \$600 million integrated research and manufacturing center for integrated circuits with structures down to 0.35 micron is being built in Crolles. The first phase, costing \$200 million, is now starting up with 2,000 large silicon wafers, having a diameter of eight inches and 0.7 micron chips, per month. The 0.5 micron engineering will be coming along also during the current year.

As early as 1994, 0.35 micron pilot production will start up. By the end of 1994, 6,000 wafers per month are supposed to be produced. The T 9000 Transputer, developed by the Inmics Ltd., Bristol, subsidiary and presently manufactured in England is also supposed to be produced at Crolles in the future.

The center is jointly financed and operated by SGS-Thomson and France Telecom. Also working there are 20 engineers from Philips, the Dutch company. In an interview with HANDELSBLATT, SGS-Thomson president and CEO, Pasquale Pistorio, stated: "We are always open to further and closer cooperative activities," although at present there obviously are no specific negotiations with other semi-conductor manufacturers.

At Crolles, development and pilot production have been combined in a single clean room in order to bring new chips more quickly onto the market and they are able to take a short cut into serial production. As a result, the "cycle time" from process development to mass production should be shortened by a full three weeks, since engineers are convinced that "flaws will be detected at the source and quickly eliminated with the close cooperation."

According to Pistorio, this year SGS-Thomson will have a good \$2 billion in turnover, after \$1.6 billion the previous year and realize a profit of \$100 million after the "goose egg" in 1992 and the heavy losses in earlier years. Pistorio is anticipating \$2.5 billion in turnover in 1994 and is again hoping for an increase in profits.

Expert: Europe Should Specialize in Small-Scale Chip Production

93WS07124 Frankfurt/Main FRANKFURTER ALLGEMEINE in German 3 Sep 93 p 17

[Article by "pso." "Minifactories for Computer Chips. Max Syrbe: Second Chance for Europe in Microelectronics"]

[Text] Munich, 2 Sep—The European electronics industry has not yet by far let development in microelectronics slip. The outgoing president of the Fraunhofer Society, Max Syrbe, who is leaving the post after 10 years, is of this opinion. Instead of moaning about

Japanese superiority and clamoring helplessly for subsidies, the semiconductor manufacturers together with purchasers should set up minifactories for application-oriented chips. Syrbe sees in such compact production facilities a "second chance" for Europe, after the European industry, except Siemens, has little by little, he says, "dropped out" of mass storage devices. Even though Siemens has in the meantime entered into a long-term joint venture with American IBM, at any rate in the foreseeable future there will be no production facilities in Germany for new memory chip generations. All the same, in Syrbe's opinion there is no cause for extra great concern, because in the future no manufacturer will be able to get along any longer in this field without international alliances. "This state of affairs will defuse the danger of extortion," that is, for instance, the threat of supplying mass storage devices preferentially to domestic customers. In Syrbe's opinion, the corporate structure and tax policy in Europe are in any case not right for the financing of chip factories for mass production. Rather, Europe's strengths lie in the flexibility of the decentralized small and medium-sized user industry. As prerequisites for availing oneself of the "second chance" Syrbe names computer-aided tools for the designing of circuits for mechanical engineering, for instance, as well as new manufacturing processes by means of which circuits can be fabricated economically in small lots also. The particular advantage of mini-chip factories lies in the smaller danger that the chip manufacturer will itself make use of the knowledge disclosed to it by the customer. On the other hand, several small and medium-sized users could also come together in the minifactories.

According to Syrbe's findings, a trend toward the minifactory, which is supplementing the large chip production facilities, can already be observed in the United States. But the beginnings, under the technical direction of Fraunhofer institutes, have appeared in Germany too. For example, components for systems for controlling automatic cameras, for a microelectronic otoprosthesis, for a cardiac catheter or for an airbag, which till now had to be imported from the Far East, have been developed and are being produced by European manufacturers. Nokia, an entertainment electronics manufacturer, is by now able again to manufacture at acceptable costs color televisions in Germany, after production time has been shortened greatly by means of chips developed here. In Syrbe's opinion, above all a network of mini-chip factories is needed now for the broad participation of small and medium-sized businesses.

Germany: Silicon-Based Superlattice Structures Developed

MI2610105493 Bonn WISSENSCHAFT
WIRTSCHAFT POLITIK in German 6 Oct 93 p 4

[Text] For a long time the view that it would not be possible to produce silicon-based optoelectronic devices was regarded as sacred lore. Unlike gallium arsenide, silicon does not luminesce when excited optically or by

electric current. Recently, however, silicon optoelectronics—using porous silicon layers—has entered the realm of the possible.

Major progress in this direction has been made by scientists at the Juelich Research Center's Institute of Coating and Ion Technology. For the first time, porous silicon layers have been used to fabricate complex superlattice structures of a kind particularly suitable for filters or semi-reflecting mirrors in combination with a light-emitting porous silicon coating. Porous silicon, which is produced in an electrochemical etching process, has a spongy structure.

Trials known as inelastic light scattering experiments performed in Juelich clearly confirmed that nanocrystallites are present in the porous layers. A comparison of recorded photoluminescence spectra with the probability distribution functions showed for the first time that the intensity of the photoluminescence (light emission following optical excitation) corresponds to the number of nanocrystallites with a diameter of about 2.5 nanometers. These findings, which have been confirmed by other research teams, demonstrated that the luminescence was definitely caused by the silicon nanocrystallites present in the porous layers.

The Goal: Red, Then Blue, Then Green

Porous silicon normally emits light in photo and electroluminescence over a broad spectrum comprising many colors in the visible range. At the applications level, it would be preferable to have a more sharply defined light emission that could also be modified. The scientists at Juelich have now presented a completely new concept that uses what are known as porosity superlattices as filters. These porosity superlattices consist of a periodic sequence of layers of differing porosity. By selecting them according to the right parameters—the thicknesses of the single layers ranged from 10 to 500 nanometers (nm) with porosities up to and exceeding 83 percent—it was possible to produce narrow-band filters. Using them reduced the breadth of the photoluminescence band by a factor of more than 10, for example.

These porosity superlattices also present an extremely high reflection factor of up to 95 percent in the visible spectral region, where only about 30 percent is observed with normal silicon layers. Initial trials show, moreover, that porosity superlattices with lateral structures measuring about 150 micrometers can be produced. This is more or less the pixel (picture element) size required for flat video screens.

NUCLEAR R&D

CTA Develops Laser for Uranium Enrichment

94SM0023X Sao Paulo GAZETA MERCANTIL
in Portuguese 7-8 Sep 93 p 7

[Article by Virginia Silveira: "CTA Develops Laser for Use in Uranium Enrichment Process"]

[Text] Sao Jose dos Campos—The Institute of Advanced Studies (IEAV) at the Aerospace Technical Center (CTA) in Sao Jose dos Campos is developing a liquid-propelled gas dynamic laser (a laser beam emitted by a gas mixture process) for use in a uranium enrichment process. The project has the cooperation of the National Institute of Space Research (INPE), which is also involved in research aimed at producing a liquid-propelled rocket engine.

What the two projects have in common is the development of a liquid fuel chamber that will be used both to emit a high-powered laser beam and to generate energy with enough thrust to drive a propulsion unit (rocket engine). But the main objective of the gas dynamic laser research, according to Marco Antonio Sala Minucci, coordinator of the leav project, is to produce a laser beam with a wavelength of 16 microns and 10 billion watts of power so as to achieve a higher concentration of enriched uranium (235), which is used as fuel in nuclear reactors.

According to Minucci, research into the laser enrichment of uranium is already under way in several countries and can be considered the most accessible and least expensive technology for Brazil because of the process used. The laser beam is generated by the liquid combustion of gases—nitrous oxide plus benzene—inside a compact cylindrical chamber. The combustion of those gases results in the production of carbon dioxide, nitrogen, and steam.

Beam

According to researcher Minucci, the three gases combined produce the substance that emits the laser beam. The process in the combustion chamber is started by an ignition system similar to that in a liquid-propelled rocket engine. "That process makes it possible to generate energy in laser form for about one or two minutes," he explains. In previous experiments, according to Minucci, the fuel chamber operated for a maximum of five seconds.

In that case, the gas did not burn uniformly and combustion usually did not occur, the result being soot and not enough power to emit the laser beam. "The ignition system in that process did not have enough energy to initiate combustion of the nitrous oxide with the benzene," he explains.

The gas dynamic laser project actually began in 1985, when scientists from the leav succeeded for the first time in producing a laser powered by a supersonic wind tunnel. The laser beam was obtained by mixing three gases—helium, carbon dioxide, and nitrogen—at high temperature and under high pressure. In that process, the gases expand rapidly in a system of supersonic nozzles. Escaping at supersonic speed, the laser's active medium—the gases—passes into the tunnel's test section and produces a laser pulse within two thousandths of a second.

According to Minucci, heating the gas mixture in the shock tube served to demonstrate the concept, but a laser pulse could only be achieved once every half hour. The radiation emitted by the laser had a wavelength of 10.6 microns and 10 watts of power.

Low Investment

Although the test time was short, the shock tube process was advantageous because of its relative ease of operation and the low investment required. "We used equipment that was already available at the leav," researcher Minucci said.

According to Minucci, the leav's new experiment with the generation of gas dynamic laser beams by a process of liquid combustion will give researchers a better chance of achieving a longer lasting and more continuous laser beam. He pointed out: "Our intention is to produce a laser emitting 1,000 pulses per second for at least five minutes."

Minucci says that the first experiment with liquid combustion should be complete by the middle of 1994. "If that experiment is successful, the next step will be to build a pilot uranium enrichment plant and then pass the technology on to industry," he commented. According to Minucci, Brazil currently imports all the fuel used to power its nuclear reactors.

But so far the project lacks the money needed for its development. "We are negotiating with the CNPQ [National Research Council] for a grant. There should be a decision on our application in October," he said. Until that money is approved, researchers are working on the project with money already available to the leav.

According to Minucci, the challenge facing the research project will be not only financial but also technological. "For us to produce a high-powered laser system emitting beams in the region of 16 microns, we will have to deal with the problem of stability during the process of heating and pressurizing the gases through liquid combustion," he explained.

Germany: Germany, Japan Develop Heavy Ion Particle Accelerator

MI2610111693 Munich SÜDDEUTSCHE ZEITUNG in German 7 Oct 93 p 37

[Article by Thomas Buehrke: "Japan Pins Hopes on Heavy Ions—Delay in German Tumor Radiation Project"]

[Text] The first particle accelerator to be used almost exclusively in cancer treatment is scheduled to enter service next March in Chiba, near Tokyo. The \$300-million medical heavy-ion accelerator, HIMAC for short, will provide radiation therapy for about 1,000 patients a year. At the projected operating cost of \$50 million a year, a year's treatment per patient will weigh in at \$50,000.

The apparatus accelerates atomic nuclei of heavy elements, such as neon, to energies reaching several hundred million electronvolts. These "heavy ions" are ideal for treating tumors as, unlike the electron or gamma rays used in conventional treatment, they yield the greater part of their energy only when they reach their destination. This means that ions of this type first pass through the healthy tissue without significant slowing and duly "explode" on target.

The depth at which this occurs depends on the initial energy of the particles, which can be regulated from the accelerator, thus avoiding damage to the healthy tissue encountered around the tumor. This accurate definition of the ions' range also makes for precise radiation of an irregularly shaped tumor. The positioning of the HIMAC beam is reported to be precise to a few millimeters.

The Japanese scientists acquired the know-how for this project largely from the Heavy Ion Research Society (GSI) in Darmstadt, where the German researchers too could have set up a treatment station attached to the accelerator, which has been in operation for three years. Radiation therapy would have taken place in parallel with scientific operation. A team comprising personnel from the University Radiology Clinic, the German Cancer Research Center (both in Heidelberg), and the GSI has long been endeavoring to set up a station of this type.

Although the federal research minister has welcomed the project, attempts have foundered to date for lack of a viable form of financing. Fitting out a radiation station with the requisite technical equipment and building an annex to the institute where the patients would be prepared would cost 8.6 million German marks [DM]. The organizers are currently attempting to involve the medical insurance companies in the project, reports Dieter Boehne of the GSI.

Meanwhile, the physicists in Darmstadt are already busy devising radiation treatment methods and devices. They have recently developed an apparatus with which the charged particles can be used to "scan" a volume of tissue: The ion beam is deflected by electromagnets in such a way as to scan a given plane in the tissue, then the beam energy is reduced to bombard another layer further to the front. As the depth of penetration into the body decreases in proportion to the energy level, a tumor can thus be treated layer by layer.

If heavy-iron therapy proves effective, the researchers intend to build a smaller accelerator exclusively for tumor treatment at the Radiology Clinic in Heidelberg. It is estimated that this would cost just under DM70 million. A machine of this type would have the advantage of providing several radiation stations.

TELECOMMUNICATIONS

Germany: BMFT Reports Digital Audio Broadcasting Ready for Market

93WS0729C Duesseldorf VDI NACHRICHTEN
in German 17 Sep 93 p 20

[Article by Veronika Hass: "Digital Audio Broadcasting Ready for Market According to Research Ministry"]

[Text]

Media Forum at the International Radio and Television Exposition in Berlin

Deutschlandradio to be First DAB Transmitter, Frequency Allotment Still Undecided

Digital audio broadcasting (DAB) is ready for market. A representative of the Federal Ministry for Research presented this opinion at the DAB Media Forum during the International Radio and Television Exposition in Berlin. This ministry has supported the development of DAB with a total of 81 million Deutsche marks to date. However, no end-user equipment is on the market yet. However, Grundig, one of the participating manufacturers, is promising DAB receivers at "acceptable prices" within two years of the decision to introduce digital broadcasting.

Digital audio broadcasting is ready for market and should now be introduced. The Parliamentary Permanent Under-Secretary Bernd Neumann from the Federal Ministry for Research and Technology (BMFT) urged this at a media forum that took place on 1 September in parallel with the Radio and Television Exposition in Berlin. He demanded that both public and private radio facilities should have the courage to innovate.

Even a technology surcharge is planned for the next increase in the radio and television fees to promote introduction of digital audio broadcasting (DAB) to provide universal coverage. The surcharge, to be in place starting in 1997, should be 20 to 30 pfennigs. Neumann warned that delaying any longer before the actual introduction would cost Germany the chance to be in a top position worldwide. In other countries, DAB test projects are already planned. These countries include, for example, Great Britain, France and Italy. A DAB test will begin next year in the U.S.A.

A panel made up of representatives from both public and private interests discussed the topic. The discussion of the panel, however, indicated that the introduction in Germany will be accompanied by a brisk debate on media policy. Among the core questions that arose again and again during the discussion was the possibility of "mapping" VHF into DAB. In this respect, the question whether the originally correct basic approach of 1:1 mapping must also be retained in the future, according to the director of the Institute for Radio Technology in Munich. The knowledge acquired previously must be

converted smoothly without being hindered by the solution of secondary or tertiary problems. In the words of Neumann, the introduction of DAB in a step-by-step manner must be the next goal. The new Deutschlandradio offers its services as the first.

In the sound broadcasting industry as a whole, concentration on the essentials will be observed as is now already happening with the cultural programs. The state secretary declared that the situation in sound broadcasting will "not be the same in 2005 as we have today for sure." The Superior Ministerial Counsellor Hermann Lossau from the State Office of North Rhine-Westphalia warns that VHF could become obsolete without DAB. At some time, it must become possible to use DAB everywhere. This is not only a question of technology but also of social freedom.

Dieter Hoff is the Technical Director of the West German Radio (WDR) in Cologne. He gave assurances that the Working Association of Public-Law Broadcasting Facilities of the Federal Republic of Germany (ARD) would not delay the introduction of DAB that is an essential factor for promoting European radio technology in the industrial sector. Prior to the next increase in fees on 1 January 1997, this cannot be considered at all for financial reasons. He repeated the demand of the ARD director that the ARD must receive executive powers for the network from Telekom. In addition, the technical parameters must be ensured in advance by coordinated test broadcasts.

DAB or VHF?

Visitors to the Berlin Radio and Television Exposition could compare the sound quality of future digital audio radio with conventional analog VHF—in a laboratory test. DAB receivers are not yet commercially available.

However, Hoff indicated that the introduction strategy developed for Germany provides for the utilization of a terrestrial simultaneous broadcasting network in television channel 12 and in sub-bands of channels 3 and 4. Up to 25% of the transmitters and TV transposers of the ARD are affected by the conversion to other frequencies. For this reason, the ARD alone would require additional financing of 40 million Deutsche marks. As these conversions would be accompanied by range and acceptance losses, it is expected that the ARD will bear the brunt of the DAB introduction.

The splitting of the 1.8 GHz band for satellite and terrestrial transmission excited Hoff as well as other panel members. Local and regional networks are to be given primary transmission rights in the terrestrial sub-band of 1.8 GHz while networks covering the entire Federal Republic receive these rights in the satellite band (channel 12, supplemented by channels 3 and 4) would then benefit DAB networks covering the entire country. First important planning parameters need to be clarified and the simultaneous broadcasting technology tested at 1.8 GHz in areas with different topologies. After

these tests have been completed, additional regions for DAB could be tested in 1994—said Hoff.

The new services that would be possible with data broadcasting but which have not yet been given any thought were emphasized in the discussion again and again. Reiner Muller from the Bavarian Land Central Office for New Media in Munich demanded that these services be put on the side of the scale to motivate vendors to offset the existing preponderance of public facilities. The introduction of DAB provides a chance for restructuring the broadcast radio landscape. This chance should be used so that the existing multiplexes are not used into the next century. The current transmission areas cannot be used for service providers.

Precisely in the expanded application potential lies the interest of consumers—says Neumann. The improved sound reproduction quality of DAB alone is not sufficient. For the development director at Creative Audio-Video-Entwicklungs-GmbH, Werner Sautfrank, the introduction of DAB is one of the few possibilities of getting the customer to put down his money—compensation that he no longer does for other innovations. Creative itself will have spent 10 million Deutsche marks on DAB by the end of 1994. Once a decision has been made to introduce DAB, equipment can be supplied at competitive prices within two years.

Neumann claims that the development of DAB will be supported by the BMFT with a total of 12 million Deutsche marks. More planning and approval activities come alone from the German's standardization process 147.

Germany: Information Technology Subsidy Program 1993-1996

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Preface

In addition to institutional research funding in the area of project support, the Information Technology subsidy

concept fulfills the research policy framework established in 1989 by the Federal Government's Information Technology plan for the future. Within the overall perspectives for funding information technology in the FRG, this subsidy concept includes research and development in telecommunications technology as well as support for information technology through EC programs and TELEKOM. Corresponding programs already exist for the areas of work and technology, as well as production technology and quality assurance; measures for the field of technologies of the 21st Century are being prepared.

In recent times information technology has continued to expand its key role as a motor for technical and industrial progress. Furthermore, like no other technical development it also opens up multiple chances and opportunities for intelligent resources and energy-saving products in all areas of life. Information technology thus represents a particular challenge for government research and technology policy. Government research support in the FRG has as its goal to assure a strong scientific and technical research infrastructure and to support the transfer of the results of the basic research to industrial application. With this objective, the Federal Research Ministry concentrates more than a third of its funding in the field of institutional support; two-thirds of the funding goes, within the framework of project support, in approximately equal parts to government research institutions and research and development in companies. The establishment of research institutions in the new *laender* offers a special opportunity but also demands additional efforts. Here, new, highly qualified partners for contact and cooperation are emerging for the information and communications technology industry. The Society for Mathematics and Data Processing (GMD), being a major research institution in information technology, is in the process of reorganizing its theme and organization and has taken into account the rapid changes in the demand for future topics in a dynamic process of institutional renewal. This support for the research infrastructure is competition-neutral and contributes decisively to the fact that Germany, thanks to its scientific attractiveness, remains a preferred location for industry. The *laender* participate in this task by means of education at academic institutions, institutes of technology and other schools in the field of information technology, thus also sharing in the research.

In the pre-competitive area the main focus of the research funding is aimed at cooperation between the economic sector and science in the form of joint projects and the transfer of know-how and, to an equal extent, with the development and implementation of norms and standards for opening up markets. In the market sector there are worldwide efforts to remove trade barriers of all kinds, and new EC barriers must be avoided. The collapse of the public-economic systems in Eastern Europe has once again showed that technical and social progress are best achieved with a market economic

system. Monitoring the competition through observation and sanctions against violations is an important precondition for effective research support.

At the European level the focus of the research policy lies in supporting research cooperation across the borders and in tackling new technical visions in various walks of life. It will be crucial for the success of European cooperation not only to increase the funding but early on to recognize the public and private need for problem solutions through information technology and quickly convert them with imagination and market savvy into new products. In the year 1992 about 280 million German marks [DM] in funding will flow from the EC to the FRG. Over the next five years this amount will double. In view of the key role of the information and communications technology for the competitiveness of the economy, the BMFT has produced a 10-point memorandum on the research support of the European Community in the field of information and communications technology and submitted it to the EC Commission. The memorandum stresses the importance of the European research policy as a measure to supplement national research and technology policies, and it urges strategic concentrations for European subsidies, easier access for small and medium-sized companies and that on the level before standards are established R&D should be oriented toward the standardization initiatives on the world market. Together with the German information and communications technology industry, with which the BMFT carries out a continuous dialog, it influences the EC's program discussions toward these objectives.

The success of all government measures depends on initiatives by industry, science and research themselves. This subsidy concept offers incentives and financial support measures, within the framework of which these self-initiatives can develop. The rapid progress in the research and development of information technology should receive additional impulses from it, over the period of this subsidy concept it will also lead to changes which require quick reactions by the research policy. This subsidy concept is therefore a part of the change which it helps bring about.

Dr. Heinz Riesenhuber Federal Minister for Research and Technology

1. Importance of Information Technology

Information technology plays a key role in the economic and social development of modern industrial nations. Like no other technical development it leaves its mark on our age and has become the most important dynamic factor in the modern industrial society. Information technology opens up opportunities for technical progress, it contributes to the improvement of people's ecological and social living conditions. At the same time it is an important factor in the competitiveness of the economy.

The overwhelming importance of information technology is based on the fact that on it supplies tools to

support intelligent handling and behavior on favorable conditions. In so doing, it reinforces a significant human ability not only to absorb information, to store it and to reflect on it, but actively to use it to create material and immaterial goods. The systems, installations and methods of information technology have therefore acquired the function of general performance enhancers, and they increasingly represent the joint, technical nerve system of the economy and government. Finally, information technology changes the shape of work and leisure time, the form of public communication and control, the way people live together, the development of the individual and of society and the forms of interpersonal relations, and it ranges all the way to the continued development of culture. In all these areas permanent impact has taken place and may be expected again through information technology and its applications.

The concept of information technology includes all the branches of the electronics industry, both applications and services

- Microelectronics
- Information science
- Communications technology
- Software
- Office technology
- Industrial electronics/microsystem technology
- Consumer electronics

The world market volume in information technology was a total of 737 billion dollars in 1989, with an above average rate of increase of about 10 percent a year. If communications technology services are included, the information technology sector recorded sales of DM 1.4 billion in the year 1990.

A recent OECD estimate arrives at the conclusion that the share of information and communications technology products and services of the gross social product of the industrial societies will double by the end of the decade. In the European Community sales of information and communications technology in 1990 were DM 350 billion, which is the equivalent of about four percent of the gross social product of the Community. This share is expected to grow to 10 percent in the year 2000. To this is added the special nature of information technology as a multiplier for technical and economic progress. Even today, two-thirds of all jobs are directly or indirectly affected by information technology.

The emphasized strategic importance of information technology consists of the fact that on a broad basis it generates interdisciplinary effects for many other areas of the economy, in particular for small and medium-sized enterprises. These send out important impulses for structural changes in the entire economy. In the FRG information technology decisively influences an area of the heavily exporting investment goods industries that is seven to eight times larger, that is to say for every DM 1 in sales by the information technology industry, DM 7 to

8 in influenced sales benefit the five largest exporting German investment goods industries.

A notable highlight of the importance of information technology is provided by an analysis published in 1990 by the U.S. Department of Commerce on the global competitive situation in the United States compared with Japan and Europe for the most promising future technologies. Of the 12 future technologies mentioned, no fewer than eight could be classed in the field of information technology.

The importance of information technology goes far beyond its key economic role. Hardly any other technical development right now leads to such radical structural changes in all walks of life as information technology. It is the source of innovations in the economic and cultural area, and it provides crucial instruments for environmental protection and economic use of resources by means of electronic measurement and control systems as well as data bases and information-processing systems.

Information technology and its increasing application in the production and service sectors has a significant influence on the working environment. It creates, changes and replaces jobs. Manufacturers and suppliers create jobs; when productivity grows from using information-technical solutions, opportunities for creating new jobs open up for the users, jobs change and opportunities follow to make the labor organization, job structure and job contents more suitable for human beings. The META studies funded by the BMFT have shown that the net result of information technology will be positive effects on the development of the labor market and the number of jobs. Recently reported studies on the effects of information technology on the European labor market have yielded similar results.

Information technology results in a new type of interlinking of social and technical infrastructures. Its effects equally influence the workplace and private life.

Information technology thus represents a special challenge for government research policy. Because of the far-ranging impact of information technology on a whole range of other policy fields such as industrial and technology policy, educational policy and telecommunications policy, research policy must not be regarded as isolated; the numerous lateral connections between these policy areas must be taken into account. For this reason the Federal Government decided in 1989 to present its policy in the area of information and communications technology in a future-oriented concept on a supradepartmental level.

The Information Technology Future Concept establishes a program framework which encompasses the government's measures to promote the development and application of information technology in various fields of policy on a supradepartmental level.

Being a framework concept, the future concept itself can thus only hint at the numerous measures. The various

departments involved in the future concept are therefore charged, each in its own field, with filling in the program framework outlined by the future concept with their own action programs.

The BMFT's present subsidy concept is being brought out at a time of rapid technical progress and considerable structural changes. The importance of applications-oriented basic research in information technology is being reevaluated and redefined worldwide; both in the United States and in Japan greater efforts have been initiated based on the results of scientific discussions. International industrial cooperation is making rapid progress and leads to new groupings. Only as strong partners do German science and the German economy stand a chance of playing a commensurate role in the increasing international competition within Europe and globally.

The objective of the subsidy concept is to maintain and expand the FRG as an attractive location for research, development and production of information and communications-technical production and to support the positions of German science as well as German industry as strong partners in the international competition. Existing strengths in research and development are to be expanded, insofar as the economy recognizes them as promising and important. The integration of information technology with other sciences such as biology, environmental and climate research or transportation research, is promoted through institutional funding for basic research in government research institutions as well as through support of projects in science and industry. All of these efforts can only unfold their full effectiveness in a public environment of technology acceptance and understanding of the social benefits of shaping the technology. Science, economy and state here face a common challenge.

The present subsidy concept describes the measures which the BMFT plans to use in promoting research and development in the field of information technology. When basic research is mentioned here, it is, in agreement with the recommendations of the Commission for Basic Research of the Federal Minister for Research and Technology, understood to be the development of a course of knowledge for technological, industrial and cultural development, from which come solutions to urgent questions and tasks in society and for intellectual life. Basic research therefore means neither isolated discipline-related scientific efforts nor scientific studies in the ivory tower insulated against the problems and challenges of our society. On the contrary: it includes a broad spectrum of searching for new knowledge, deeper understanding and proposals for solutions to sets of questions which come from science itself, from industry or from social need. Depending on the problem and the scientific field, it therefore often extends all the way to practical implementation in products and methods, without, to be sure, overstepping this threshold. Since it must remain creative, basic research is to be kept free of the shackles of time restraints from the institutional

research support of the Federal Government and laender. In normal instances it offers various options to be selected for utilization by the economy; however, quality and originality usually determine the opportunities for practical application and implementation, as well as the funding within the framework of BMFT research projects.

Research and development play a particularly important role in information technology, since the enormous development pace needs major efforts in strengthening the national research infrastructure and requires especially large research and development investments in the information technology and consumer industry. The research intensity in this sector can be illustrated by the fact that about one-fourth of the total worldwide spending on research and development can be attributed to the field of information technology.

It turns out that in the FRG and Europe, despite greater allocations by companies for R&D and despite reinforced government research subsidies on the national and European levels, it has not been possible to reduce to the desired extent any weaknesses that have occurred in the past in industrial production and application of information-technological goods. This applies to the field of microelectronics and computer technology in Europe and in the FRG also the field of software production, whose share of the information and communications technology systems is showing an increasing trend.

A strong research infrastructure and government support for R&D involvement are important preconditions for the international competitiveness of research-intensive industries, to be sure, but government R&D programs can—by themselves—not guarantee industrial competitiveness. For that reason a continued development of the prerequisites is needed so that the innovative capability of the companies—particularly in medium-sized and small ones—will be strengthened and placed in a better position to produce and use modern information technologies in ways suitable to the market and competitively. But government subsidies cannot replace the important efforts of the information technology and user industry itself.

In Europe more and more voices have recently been raised which in addition to research policy call for supplementary industrial and technology policy measures to improve the dynamic of innovations ("Report of the Commission of the European Communities of 3 April 1991: The European Electronics and Information Technology Industry—Situations, Opportunities and Risks, Proposals for Action").

The Federal Government stated its position on these proposals in the decision by the Council of the EC Ministers of Industry on electronics, information science and communications technology of 18 November 1991. The orientation toward the global market must apply to information technology as well. Restrictive trade policy

measures to protect the domestic market are rejected. In the future it is therefore important

- to open up European cooperation to enterprises outside Europe, whereby efforts are to be made to achieve mutual benefit and balance
- to support the establishment of production sites in Europe by companies with a capital majority outside Europe, in which the link to corresponding R&D in Europe appears particularly important
- to assure worldwide, open competition in the field of information technology and to prevent market-dominating monopolies.

The rapid change caused by information technology in science, economy and society also means constantly new requirements for research policy. The present subsidy concept must remain open to such changes in order to be able to open up new options for scientific and technical progress. It is thus understood as an offer to science and technology that it will keep up with international demands in the innovative process of information technology.

2. Goals and Functions of Government Research and Technology Funding for Information Technology

2.1 National Tasks

The overriding goal of government research and technology policy lies in keeping Germany attractive as a research location and expanding this function for companies in the field of information technology.

One crucial prerequisite for being an attractive site for high-tech industry is well trained professional labor. This is one of the indisputable strengths of the FRG. That is why the research policy is also aimed at finding information-technical solutions in the production and service sector with which the existing expertise can be utilized and further developed and in which through new forms of work organization, made possible by the progress in information technology, the creativity and motivation of the skilled labor is reinforced and the experienced knowledge of the professional workforce becomes part of the information technology.

Of equally great importance is a favorable innovation climate, which originates from a strong research infrastructure. The BMFT's funding measures are therefore directed toward strengthening application-oriented basic research in the field of information technology and accelerating the transfer of research results to practical industrial application.

In the Fraunhofer Society, the Max Planck Society, academic institutions, major research facilities and Blue List installations the FRG possesses outstanding institutional preconditions. The spectrum of tasks and the goals of these establishments are set out in detail in the future concept. The future prospects for information technology in the Max Planck and Fraunhofer Societies, at large research establishments (GMD, KfA [Juelich Nuclear Research Facility], KfK [Karlsruhe

Nuclear Research Center]) as well as at the Blue List institutes—including the research concentrations at newly founded institutes in the new laender—are given in the supplement.

This research supplies the foundation for the innovations of tomorrow, but this innovation can only take place through a functioning technology transfer. That is why the BMFT's subsidy measures put priority on including every conceivable transfer mechanism in an intensive way. For example, the academic institutions of the FRG are indispensable for the transfer of technology, because they send out highly qualified graduates who make use of their innovative knowledge from research projects in their professional work. Particularly small and medium-sized enterprises obtain their innovative strength largely from this "technology transfer by means of heads." Above all, in order to assure this type of technology transfer, it is the declared goal of the BMFT to integrate the academic institutions closely into the research support.

With the concept of scientific infrastructure in this subsidy concept is meant broad understanding of institutionally assured research at universities, government research establishments outside universities and in the economy. As is also shown in international comparisons, a balanced relationship between these three areas, as well as the measure of their mutual transparency and collaboration, competition that strengthens performance and the personnel exchange connected with it, represent essential prerequisites for success and quality of results. Structural rigidities in the field of scientific infrastructure, mutual isolation or sterile parallel existence hinder or delay new developments and extraordinary results. By support of the scientific infrastructure in this subsidy concept is also meant regular understanding of the effort to make the structures themselves vital, flexible and mutually fruitful.

In a rapidly developing sector such as information technology, it is important in international competition to push the conversion of research results into industrial application. The BMFT's support measures in the field of application-oriented basic research are therefore predominantly organized in the form of joint projects between science and industry. The industrial enterprises share in the R&D spending and both groups participate by sharing the work in the interest of the goals defined by the industrial partners. In this manner synergies are mobilized in cooperation between research groups with government financing, using engineers from industry to the advantage of both groups. Furthermore, it is precisely the close cooperation between science and industry on joint projects which produces new, interesting questions for basic research. Also, the supply of competent next-generation scientists is enlarged, who at an early stage have learned the efforts required to convert scientific results into industrial application. That is an experience which facilitates the transfer to industry.

and, hence, the technology transfer inside people's heads. Efficient project management, such as through project sponsorship arrangements, and effective methods for monitoring success, raises the degree of impact of the subsidy measures.

The considerable R&D efforts of the industry in the field of information technology—they are about seven times greater than the government funding—are shown in the following statistical breakdown; they form the basis for the supplementary government funding.

Industry Spending for Information Technology R&D (million DM)				
1983	1985	1987	1989	1991 (est.)
5,390	6,930	8,050	8,540	9,500

Source: SV Wissenschaftsstatistik GmbH, (calculation basis: 70 percent of the electrical engineering sector)

Also disproportionately greater is the advance work in R&D demanded from the users of information and communications technology components.

2.2 European Tasks

The national research infrastructure and the companies' own R&D involvement are important cornerstones for the European research and technology community. The European ESPRIT and RACE subsidy programs in the field of information technology are aimed at increased cooperation by scientists and engineers across national borders and at creating the technological foundations for a European information technology industry that can keep up with the global competition of the 1990s. The impulses generated by an innovative national research environment play an important role in this creative process on the European level.

In the preliminary program phase on the Community level promising topics must be picked up early and the results brought into the European discussion. That way national basic and application-oriented pioneering research can share in shaping the goals and tasks for the research programs of the European Communities. The quality of the European programs depends decisively on the stimuli originating from national research contributions. Besides, the expertise gained within the framework of groundlaying national work makes the participants interesting partners for European cooperation and establishes the preconditions for successful participation in European programs. That is why national and European research efforts are mutually dependent and supplement each other.

The EC's R&D programs must also provide a contribution to the strengthening of the economic and social contents of the Community and to promote their harmonious joint development ("cohesion goal"). In so doing, the scientific and technical quality of proposals must always be taken into account; in practice, however, this conflicts with the interests of member nations with lower standards of technology, primarily as regards the overriding strategic importance of information technology for European competitiveness in the global competition with the United States and Japan. In its 10-point memorandum on research support by the European Communities in the field of information and communications technology the BMFT has demanded political solutions at the Community level. A proposal for a solution

introduced by the BMFT in the most recent debates on a Fourth R&D Framework Program could involve opening up and utilizing the specially appropriated EC funds for regional and structural policy more heavily for R&D projects and for establishing the scientific and technical infrastructure.

Another task for the national research policy consists in supporting the EUREKA initiative. EUREKA offers a supplementary incentive to the European Communities' funding programs that have a broad subject approach. While Community programs are intended to strengthen European cohesion, which sometimes also leads to technologically less developed regions or industries merely being elevated to the level of the more highly developed ones, in EUREKA the participants from the beginning deliberately establish strategic concentrations on a narrowly defined, joint objective. Examples in the field of information technology are the creation of a system for high-definition television (HDTV), the initiatives for expanding the European system of know-how in the field of microelectronics (JESSI [Joint European Submicron Silicon Project] and the EUREKA software factory (ESF). These strategic projects are based on cooperation between a few, particularly strong European firms and top teams in basic research.

With respect to European cooperation, the overall system of government support for information technology essentially consists of the three elements described:

- National basic research to acquire preliminary knowledge
- European research support through the European Communities to strengthen international competitiveness (Europe as a high-tech location)
- EUREKA initiatives for concentrated use of resources by interested, equal partners on strategic objectives.

Each of these three elements fulfills its specific role for the entire system of R&D. It is the task of the research policy to furnish a lively and fruitful exchange of the individual elements. This also includes special measures to integrate the new laender

The BMFT subsidy measures are embedded in the following overall Federal Government strategy within the framework of the Information Technology Future Concept:

- Priority is given to strengthening the scientific and technical infrastructure of the FRG in the field of information technology; one-third of the research funding is concentrated to institutional research. This funding is competitive-neutral—the FRG must remain a preferred industrial location thanks to its scientific attraction.
- In the pre-competitive area the focal point of the support is on cooperation between science and the economy. Further, there is implementation of new standards and norms through cooperations and joint projects as well as innovations in applications and services.
- In the area of providing for daily life, efforts are made to further develop information technology and to enlarge its application possibilities in order to bring about preventive labor and health protection and to expand the range for human-oriented organization of working conditions. The efficiency of environmental protection will also be improved through information technology.
- Investors from all over the world are to become interested in the FRG as a location for production, research and development.
- Obstacles to utilizing technological options which occur in small and medium-sized enterprises will be reduced by means of specific transfer measures.
- In the market sector a decrease in competitive imbalances and trade barriers of all kinds will be sought worldwide; new EC barriers must be avoided.
- The division of labor in the world is best assured through a market-economic system. The conditions for worldwide open competition must be monitored, however, and if necessary improved through government intervention.

3. Prospective Applications

The focal points of the support for R&D in the field of information technology will be determined by the future prospective applications for information and communications technology. Among them are:

- Electronic imaging techniques, in particular high-resolution imaging systems (HDTV), display technology
- Digital ground broadcasting (DAB [Digital Audio Broadcasting])
- Safe and environmentally compatible transportation systems
- Improvement in the working conditions and human-oriented job design
- Computer-supported development, production and logistics in all branches of the manufacturing economy
- Microsystem technology for minimally invasive surgery or gentle radiation therapy

- Preventive work and health protection, further development of the level of professional qualification
- Building a bridge between biology and information technology, particularly with respect to new principles of information processing and biosensors
- New information systems for environment and environmental protection
- Creation of the increasingly more clearly evident "networked (informed) society" with its growing demands for quality and security in information processing and communications
- Telecooperation

Some important prospective applications will be stressed in the following. They serve as the principal foundation for the derivation of concrete funding concentrations by the BMFT.

Prospective applications

3.1 High-Resolution Image Systems, HDTV

The most important development in the field of high-resolution image systems is the large-screen television of the future, abbreviated as HDTV (high definition television). Compared to the television of today it offers the viewer large images in brilliant quality and a new, wide format, similar to movie film, which is better adapted to the human field of vision.

HDTV involves primarily a qualitatively new television service. But with its high picture quality which approaches that of movie film and photography, HDTV, in combination with data processing, will mainly penetrate into many professional applications beyond the consumer area such as the fields of medicine, education and advertising, printing technology and teleconferencing. HDTV will thus become the engine for a variety of innovations in sectors which make use of visual information and representation.

HDTV is an important lead project for the European information technology industry. Europe still has a viable industrial base in the area of television (in contrast to the United States). The television of the future is the pacesetter for the entire sector of consumer electronics. The strategic importance of the consumer electronics area lies in the fact that this area alone represents the know-how for mass manufacture of electronic high-tech products, a know-how which is just as crucial for the entire PC market as for the mass market of telecommunications and office communications terminal equipment.

Another important connection exists between microelectronics and consumer electronics: In Europe 26 percent of the microelectronics production goes to consumer electronics; looking at the world market, this share is as high as 38 percent. It is no accident that the collapse of the U.S. consumer electronics industry resulted in problems in the microelectronics field. Conversely, in Japan the strong consumer electronics market is the basis for its market power in the microelectronics field.

The success of HDTV is therefore of considerable significance for all of microelectronics. If Europe were to lose the mass market for television, the consequences, particularly for the microelectronics sector, would be grave.

In 1986 30 companies and research establishments joined together under the leadership of Bosch, Philips and Thomson on a EUREKA project (EU 95) in order to meet the challenges of HDTV. By pooling the development resources the European industry succeeded in offering an alternative to the Japanese HDTV system. On the occasion of the Olympic Summer Games in Barcelona and other major events, the maturity of the European HDTV system was impressively demonstrated. From a technological aspect, EUREKA Project 95 and the BMFT's support are a complete success. It is now the primary task of the industry, the TELEKOM companies and the broadcasting promoters to introduce HDTV and to help this technical success to become a marketing success. The BMFT has therefore initiated a platform from which these partners can promote the introduction of HDTV. On the political level the member nations of the European Community have agreed on a Europe-wide introduction of HDTV and have given the EC Commission a coordinating role for measures on a supranational level.

In the future the BMFT's role will be limited to supporting key technological components and system components for digital HDTV, because the next innovative step in the field of television will be digital HDTV transmission. A joint project called Digital HDTV headed by the Heinrich Hertz Institute devotes itself to this future task.

Strategic contributions to the prospective applications of HDTV are made by the JESSI project in the form of application-specific, highly integrated circuits, concentration on display technologies as well as microsystem technology.

An important task for the future consists of digitizing all image services, including the mass communication services of television and HDTV, in order to meet the continuously growing demands for higher quality and miniaturization of all image, processing and reproduction equipment and to be able to utilize the available transmission channels more efficiently.

Prospective applications

3.2 Digital Ground Broadcasting

The technical standard for today's "analog" VHF broadcasting essentially originated in the 1950s. Meanwhile, digital technology has staged an entry into many fields. Thus, the digital compact disk (CD) has set the standard for improving audio quality (CD quality). Furthermore, today one senses, primarily when driving a motor vehicle, the system-based weaknesses of analog VHF radio that make themselves noticed through reception difficulties.

The enormous progress in microelectronics now creates the technical preconditions for developing the digital audio broadcast system of the future, which

achieves the reproductive quality of the CD disk and can also be received in a car without interference. With the EUREKA project DAB (Digital Audio Broadcasting) a proposed standard is being worked out for future digital ground audio broadcasting in a European research cooperation.

After extensive preliminary work, this project was adopted at the Fourth EUREKA Conference on 16-17 December 1986 in Stockholm. Seventeen companies and institutes from seven European nations participate in this EUREKA project. With a total funding of DM 180 million, a European proposal for the new standard is to be worked out and presented to the international standardization committees. German companies and research institutes, which traditionally influence the technical development of broadcasting, are here assuming a dominant role. The BMFT supports the German share with DM 48 million. The industrial work receives 50 percent funding, and the research facilities 100 percent.

DAB forms a seamless continuation of the BMFT's efforts to open up future mass markets in the field of information technology for European industry by supporting R&D at the pre-standardization stage.

The fundamental idea for these pre-standardization R&D projects is to establish the technical standards that point the way with a comparatively modest financial incentive for exploratory R&D work, which, if possible, gathers the European resources within the framework of EUREKA. This work, in turn, is an indispensable precondition for the industry's ability subsequently to be able to open up the mass markets behind the new systems.

The realization of digital ground audio broadcasting is also a first-class technological challenge, however. Converting the complex technical system solutions for DAB into consumer electronics products has only become possible through the progress of microelectronics. The DAB concept requires a series of highly complex integrated circuits in the reception equipment which can be economically produced by using the most modern microelectronics. Due to the large numbers needed in the consumer electronics sector, the mass market behind DAB will result in an enormous demand for integrated circuits with super-modern technology. This wave of demand is of extraordinary importance for the European microelectronics industry, which in the EUREKA project JESSI has made it a goal to maintain a strong European microelectronics base to assure unlimited access for chip users. Without the demand for chips from mass applications such as HDTV or DAB, JESSI itself would lack the necessary economic basis for outstanding technological performance. Insofar the EUREKA projects supplement each other for the standardization and strengthening of microelectronics and help Europe assert itself successfully in important high export industrial sectors against the competition from the Far East.

Prospective Applications

3.3 Telecooperation

Innovative telecooperation and telepresence systems are created by merging communications technology and information science (to become telecommunications technology). They are the precondition for the increasing use of distributed administrative, management and labor processes. The trend toward decentralized solutions for organizational, cooperative or information-logical functions in collaboration between people poses a major challenge to research, as well as to the development of the most modern infrastructures.

Only with the help of an innovative communications and information technology will it be possible to realize a functional and efficient division of labor between work units separated in space and time. Despite this separation the workers should be able to complete their work cooperatively without limitations. Also, extensive systems-technological support is to be available to them for the cooperative functions. The telecooperations will thus in general lead to a leap in the quality of collaboration between people.

One example is the united Europe, with its major demand for cooperation between governments, parliaments and administrative units. The same applies worldwide to business enterprises. An obvious first application field in the ERG is the telecooperation system between Berlin and Bonn to support the government and parliamentary functions. The German Bundestag has awarded a corresponding contract for implementation of this information technology system.

Telecooperation is based on information and communications-technical solutions in the three fields of communications, cooperation and coordination (K.3).

- Communications technology must make it possible in the most natural manner and in different ways (cable-guided or by radio, narrow-band or broadband transmission) to exchange multimedia information safely and quickly. Already existing individual solutions are to be replaced by complex integration techniques based on powerful communications networks.
- Cooperation requires user-friendly systems for joint work on the same document (joint editing) and assured access to joint multimedia and distributed information bases. Fundamental research tasks involve working out transparent and, from the aspect of applications, open and compatible systems.
- Coordination is an indispensable precondition for any kind of cooperation based on division of labor. As an independent assistance function in information technical systems, coordination support becomes all the more complex the more extensive the cooperating units and the distribution in space and time of the tasks. Progress in the field of computer-supported cooperative work (CSCW) is therefore an important prerequisite. Designing the system's behavior to conform to human behavior and improving the support for joint work are indispensable elements for the acceptance of these functions.

In order to realize these concepts, the presently available technology is not sufficient by far. An innovative process must be initiated, in which German industry as well can assume a pioneering role.

A comprehensive Telecooperation Program is being prepared within the framework of the BMFT initiatives for the Berlin-Bonn information technology system. It will be designed as an integrating project, in which science and the manufacturing industry will cooperate closely. The Society for Mathematics and Data Processing will bring in its POLIKOM project here.

Early inclusion of the industrial partners is essential, since, for lasting success, it is not only important for science to grapple with important questions but for the subsequent orientation of the research to be aimed at real application challenges and rapid availability of concrete system solutions.

Prospective applications

3.4 Building a Bridge Between Biology and Information Technology

Until now the development of the information technology has primarily been determined by possibilities for technical engineering solutions to the application problems. This is particularly true for the field of pattern recognition and robots. When biological models and methods of application appear useful, one has so far been satisfied with coarse analogies, such as with smaller neural networks.

However, deeper understanding of biological processes involving behavior control could bring distinct progress. This may be expected mainly when attempts are made to take the functional topology of biological nerve systems and their learning processes into more detailed account. In so doing, the functional understanding of neural systems would also experience significant enrichment. But in order to be able to understand the complexity of entire nervous systems and the signal processing in them, close interdisciplinary cooperation is unavoidable.

The combination of powerful parallel computers and evolutionary algorithms has already demonstrated its capability of solving extremely complex problems in many practical applications. With their distributed, sub-symbolic and frequently also fuzzy knowledge representation, both neuroinformation science and evolutionary algorithms point out new ways to overcome the boundaries reached in traditional AI (artificial intelligence) research (inflexibility and bottlenecks in rule acquisition with conventional expert systems).

The know-how for successful continued development and application of these algorithms exists in the ERG today. Particularly, the processes of adaptive learning

and self-adaptation of strategy parameters form a promising basis for further improvement of the robustness and efficiency properties of evolutionary algorithms in the fields of:

- Technical optimization
- Production planning
- Control of dynamic processes
- Pattern recognition, image construction
- Optimization of neural networks
- Robot control, inverse kinematics

All told, this "biological approach" to information technology can be shown as follows:

Bioanalogous Strategies for Information Systems

- Neuroinformation Technology
- Biosensors (integrated sensor methods)
- Learning, bio-electronic interface (adaptive information reduction)
- Bioeffectors (electric eye, nose, feeler, audio system, prosthetics)
- Bioprocessors (neuroprocessor, associative memory based on electronic, photonic and molecular-electronic technologies)
- "Natural computing" networked systems (neural network models, learning strategies, language recognition, fuzzy logic decision models)

Bioinformation Science

- Molecular bioinformation science (genome research, protein design, biocatalyst development)
- Evolution strategies (self-adaptive algorithms, self-organization, artificial life)

Research projects in these subjects will be given increased support in the future.

Prospective applications

3.5 Information Technology Systems for Safe and Environmentally Compatible Transportation

Highway, rail and air traffic is of overwhelming importance for the mobility of people and for transportation of goods. In Europe it represents a significant component of the social and economic structure. The individual mobility offered by the motor vehicle and highway network is of great value to the freedom of the individual and to the national economy as a whole. But the high degree of motorization also has tangible, detrimental consequences

Traffic Safety

Despite all the progress achieved so far, the number of traffic accidents continues to be high. There is special danger for unprotected persons involved in traffic. A significant increase in safety is a central theme for activities to improve the present situation

Environment

Emissions of harmful substances and noise from motor vehicles affect people and ecosystems. Improvements in this field are important for the acceptance of highway traffic.

Performance and Profitability

The limits of performance of the highway network are frequently exceeded. This overloading gives rise to slow-moving traffic and congestion and thus longer travel times, higher fuel consumption and a greater burden on the environment

The major advances in microelectronics, sensors, telecommunications and information science will pave the way for important improvements in vehicle and traffic technology. They permit solutions which until now were not possible or did not make sense for technical and economic reasons, in which systems in the vehicle correspond with installations by the side of the road. The technical progress enables intelligent vehicles on intelligent roads

From the research programs of the last few years (PROMETHEUS DRIVE) comes a large number of approaches which can be considered for additional research for medium-term application in transportation. The most important elements here are collision avoidance, distance control, digitization of transportation routes and cooperative traffic management, among others, which are supported by the BMFT's Fourth Research Program

More future-oriented research fields in information science must primarily be aimed at methods to master the complexity which also plays an increasing role in many other economy and technological fields

Among the R&D questions relevant to safety and information science are

- Methods/processes for developing controlling complex systems (reliability, verification and proof, standards)
- Image recognition, observation and evaluation, computer vision (software and optical algorithms, software)
- Interpretation of natural environments in traffic (recognition of human traffic behavior, etc.)
- Systems to support the driver during nonfixed boundary conditions
- Simulation models and associated interactive visualization techniques for crash simulations (such as bumper impact for railwagons)

Prospective Applications

3.6 New Information Technology Systems for the Environment and Environmental Policy

The area of issues in this technology area is broad and represents an important building block and undoubtedly an important step towards environmental protection measures. It is expected that

thinking and in decisions on politics, economics, industry and science. Problem solution concepts and strategies which make sense in the long term can only be worked out based on knowledge of processes in nature and technology and the complex interaction between the two. Both in preparing the foundations and in the practical implementation of the concepts, and finally in monitoring the implementation and success, information science and information technology even today play an indispensable role for monitoring and early warning systems, environmental information and planning systems, in order to mention just a few.

Typical of environmental applications are unusually large, heterogeneous and distributed data and information quantities from biology, physics, chemistry, meteorology and from all technical disciplines, often supplemented by information from economics and administration, which must be acquired, administered, evaluated and displayed.

A great deal of relevant information accumulates in environmental test networks. Other information sources are biocadastrs, data bases in species and landscape protection and information systems for planning and implementation in administration. Linking the information from these sources, in the future beyond laender and national borders as well, within the developing system of broadband networks opens up problems of interoperability and standardization with respect to communications, data quality and evaluation and thus—quite fundamentally—the problem of representation and utilization of meta-knowledge in the environmental sector.

Large quantities and varieties of data and complex functional relationships require the possibility of compact information storage and display suitable for problems and applications. Here there are close connections with current research efforts in the field of distributed, heterogeneous data bases, object data bases and geoinformation systems. Current developments toward super-computer-supported visualization and large-picture display technique are gaining importance here as well. Techniques based on this for the conception of intelligent user interfaces, which enable the non-expert and computer layman to have optimal use of the information systems, are necessary.

The multitude of influencing variables and the complexity of the interactions in environmental applications often result in software systems that are extensive, have a complex structure and are computer-intensive. Here there is further a need for software drafting techniques and tools, particularly from the aspects of portability, reusability and modifiability of the software. Basic questions in this field involve primarily a general coupling of data bases, mathematical models and the associated evaluation algorithms.

Often a precise representation, sufficient for solving the problem, of the complex interactions in the form of closed analytical models is not possible, and the problem

solutions must be deduced on the basis of empirical and heuristic knowledge. This is where knowledge-based methods find increasing application in decision-support systems, partly also with components for processing uncertain knowledge or for working on multidimensional goals.

For large-area detection and acquisition of environmental damage (forest), methods of interactive high-performance image processing are being developed.

Prospective Applications

3.7 German Research Network

In the United States the establishment of computer networks in the scientific field in the second half of the 1970's helped stimulate the willingness to cooperate among scientific establishments and led to new forms of communication with the help of the electronic media being offered. The BMFT took up this idea in 1983, but tied the realization of a network to the use of the internationally standardized producer-neutral norm for open communication (OSI), whose usefulness was thus to be demonstrated for the first time in a large, joint computer system.

The science field founded, specifically for this joint network, a network to promote a German Research Network (DEN network), which today has more than 200 members, among them all the universities and major research institutions as well as numerous industrial enterprises.

As a recipient of funding from the BMFT the DEN network has so far established a communications organization with a subsidy volume of DM 75 million, which is used for the exchange of news and data as well as for remote access to special computers in different locations. The success of the DEN project has permitted the DEN network and its technical concept to become a model for comparable projects in the European partner nations. This pioneering role is the essential reason for the creation of the EURKA project COSINE, which across Europe has led to a linking of national research networks on the basis of a coordinated technical concept.

The DEN network will concentrate its activities over the next few years to setting up a high-performance data network, to broadband European networking within the framework of the EURKA project COSINE and to coordinating the international network connections. As an additional task the DEN network emphatically pursues the integration of the scientific establishments in the new laender into the German Research Network and the opening of this network, as well as the European COSINE network, to the Central and Eastern European nations.

4. Subsidy Concentrations

The goal of the BMFT's research subsidy is to speed up the necessary basic innovations required to realize the prospective applications listed in Chapter 3. In parallel with this the framework conditions for the future use of technologies such as the standardization of computing

development and issues of environmental compatibility and safety, must also be taken into account at an early stage.

The following basic innovations are the prerequisite for realizing the above prospective applications:

—Continued Development of Microelectronics Based on Silicon in the Submicron Range

Here is where new design methods are needed for rapid, reliable systems which can be tested and diagnosed, as well as design methods and production techniques for logic circuits, particularly for customer-specific circuits (ASICs). This work is largely being carried out within the framework of the JESSI initiative. A special goal is also the opportunity for small and medium-sized companies to use the design methods. The development of microelectronics provides important stimuli for high-resolution television, high-performance computers and digital communications systems (such as digital ground radio, see 3.2). This subsidy concentration is described in Chapter 4.1.

Microelectronics and Optical Electronics Based on III-V Semiconductors

The special properties of semiconductors based on III-V compounds enable the integration of electronic and optical components for signal transmission and signal processing. In addition, they permit higher processing speeds. This opens up application fields in the area of supercomputers, navigation and warning systems, traffic control systems as well as satellite television. This subsidy concentration is described in Section 4.2.1.

Nanoelectronics

With the help of highly developed structuring and growth methods it is possible today to produce well-defined regions within semiconductor crystals. If very small structures are produced with geometric dimensions, perhaps in the size range of 100 nanometers and below, the physical description must increasingly include size-dependent quantum effects. These quantum effects, which could become drastically noticeable in the electrical behavior, offer totally new opportunities for the design of electronic components. Such nanoelectronics can in principle be realized with all semiconducting materials. At this time a few representatives of the III-V compound semiconductors seem particularly promising, but silicon or the silicon-germanium system also show a greatly promising start. This funding concentration is described in Section 4.2.2.

Molecular-Electronic Memory Technologies

The limits of silicon-microelectronics will probably have been reached with the gigabit memory components. It is possible to achieve higher memory densities through new memory media such as embedded molecular systems. Basic research to ascertain the physical and chemical modes of action of such molecular memories is needed. This funding concentration is described in Section 4.2.4.

Production and Application of High-Temperature Superconductors

Superconducting offers the basis for new types of principles of function for electronic components and interconnection techniques. High-temperature superconducting can open up the potential for a key technology to increase the performance of conventional electronic systems. This subsidy concentration is described in Section 4.2.4.

Basic Technologies for Photonics

In photonics the transmission and processing of information takes place with optical and optoelectronic means. The information carrier is light. Due to the very high transmission capacity of optical transmission paths and the opportunity for optical parallel processing, it is anticipated that in comparison with conventional systems significantly more powerful information processing systems can be realized with respect to speed and processed information quantity. Even today optical transmission systems for high-speed information transmission are without competition. Long-term goals are optical parallel computers as well as optical neural networks. This subsidy concentration is described in Section 4.2.5.

Application of Artificial Intelligence

While the expert systems developed so far have now experienced increasing application in the economy, the future shows an integration of artificial intelligence methods in complex problem solution systems and their combination with neuroinformation for machine learning. Genuine challenges and extensive research fields are also contained in processing natural speech and in image processing. This subsidy concentration is described in Section 4.3.1.

Neural Networks, Bioinformation Science

Connected with the transition from classical sequential information processing to fine-grained, distributed and parallel storage and processing of information in neural networks is the particular capability of learning and remembering and the possibility for associative supplementation of partial information through knowledge that is present in the system. Such flexible and adaptable systems can be borrowed from nature. They have the greatest prospects for application. Within the framework of bioinformation support additional learning effects are to be obtained from biology and medicine. This funding concentration is described in Section 4.3.2.

Massive Parallel High-Performance Calculation

In the next decade information development will be characterized by massive parallel computer architectures with tens of thousands of processors. This kind of computer promises a 100 to 1,000-fold leap in performance compared to today's vector computers (or fields of work stations). The economy will profit considerably from these developments, since expensive experiments will largely be replaced by unique computer simulations. While

the corresponding hardware developments are being pursued in a rapid and promising way by the industry, there is a considerable need to catch up in the method and software field, in particular in the application software area. This subsidy concentration is described in Section 4.3.3.

The totality of the basic innovations pursued in these subsidy concentrations supplies the technological foundation for shaping our living conditions in human and environment-oriented ways through information technology. This involves primarily new opportunities for making the cooperation of human and information technology more user-friendly. Optimal utilization of these possibilities in practice can be achieved when a dialog between developers and potential users can be started at an early stage. For only the potential users are in the position to develop the requirements and criteria which make the system "user-friendly" in a practical way. An overview of the future tasks of the information technology is found in Fig. 11 [not included].

By working out the funding concentrations, the BMFT is not only following up on its pledge for the Federal Government's future commitment for information technology in 1989, but for the first time it combines a concept to promote information and communications technology with the supplementary roles of the BMFT, the R&D programs of the European Communities and the German Bundespost (TELEKOM). The large range of research fields in the area of information and communications technology calls for a concentration of the BMFT's support on areas where research and development of the FRG has strengths and which are also recognized by the community as promising for the future and strategically important. With the goal of assuring and further expanding the existing strengths in science and industry in the international competition comes another necessary selective use of national funding means. Concentration and focus based on a division of labor will also be growing beyonds in the future (see cooperation as well as with the projects of TELEKOM, which should be regarded as development in communications technology for entrepreneurial benefit (see Fig. 10) [5].

4.1 Submicron Silicon Technology

4.1.1 Strategies in Microelectronics Development

In the European Community awareness has grown in the last years concerning the performance of a single national economy is no longer enough to bring the key technologies, although by information technology is the required market on a global scale. This can be illustrated by a figure: "The second European supplier of integrated circuit ICs is only at 15th place" in the world. At three European IC companies together are still smaller than the first one (the largest Japanese manufacturers alone). However, the structural weakness of the European microelectronics industry can only be helped by the continuation, however, and not through government subsidies.

A number of companies have joined together on the EUREKA project JESSI (Joint European Submicron Silicon) to mobilize their synergies by combining the research potentials which exist in many places in Europe in subcritical mass. This bundling of resources on the level of research and development is a crucial precondition for assuring the future of microelectronics in Europe. Such a research cooperation is not enough, however, to assure Europe of being a production site and to overcome the structural weaknesses described. The research must be supplemented by a network of strategic cooperations between businesses, which the industrial enterprises must gradually develop on their own initiative.

The leitmotif in conceiving the JESSI research program can be summed up as follows: Acceleration in implementing technological know-how in marketable products. At the beginning of the JESSI program was the identification of market segments, which are of decisive importance for the European industrial landscape, among them are the automobile industry, telecommunications, consumer electronics and the machine tool industry. By analyzing the competitive disadvantages with which these industries struggle in comparison with their overseas competitors when it comes to microelectronics, strategic tasks were formulated in the JESSI program which are oriented toward the research work.

Based on a few outstanding examples for the branches of industry mentioned above, which will not reach their full economic importance until the second half of the 1990s, in JESSI a research program was set up which will improve the cooperation of those involved in developing new systems in the field of information technology. It begins with the system designers and ranges from chip manufacturers, equipment and material suppliers all the way to institutional research which works in these fields. Of major significance in this process is the bridging of the traditionally large gap in Europe between IC users and IC manufacturers. The solution to this problem represents a difficult task even on the national level. To this extent JESSI's mission of improving cooperation between the various participants is an extremely complex task. That is one of the reasons why JESSI does not represent a government-conceived program but based on EUREKA principles, from the beginning was designed as a project worked out and organized by the industry itself. (The technological sequence of microelectronics in international comparison is shown in Fig. 12 [not reproduced].)

In conceiving the strategic projects in JESSI the industry has developed the individual work packages from the desired application. It is not the technology which determined the application, but the other way around, the application, that is to say the future market, which determines which auxiliary technologies are needed. This begins with making more efficient design tools available for the systems engineer, for whom future opportunities for new technology must be integrated as early as possible, including the development of the

necessary manufacturing processes for chips and ending with making the corresponding manufacturing equipment and materials available which must meet the future demands. Nonindustrial research is given an important role in this concept: It must, in close cooperation with industry regarding the desired goals, work out ways to solve identifiable bottlenecks, research alternatives and explore the limits of silicon-based microelectronics.

At present about 40 industrial partners and more than 20 nonindustrial research institutions from the FRG participate in the programs.

The funding planned for JESSI is allocated in approximately equal parts on the one hand to the "flagships" listed in the application fields and, on the other hand, to the strategy projects on manufacturing technology including equipment and materials development. However, assuring the indispensable technological basis for application-specific integrated circuits (ASICs) essentially takes place outside the JESSI program. Here, it is primarily the most recently agreed-on cooperation between Siemens, IBM and Toshiba that is of extraordinary strategic importance, since it guarantees the availability of the most modern silicon MOS (metal-oxide semiconductor) technologies until far beyond JESSI.

In addition to the projects defined in the JESSI initiative, fundamental work is being supported in the fields of new circuit structures, new component concepts and design methods as well as the key subject of nanoelectronics, because with the "JESSI technology" and the goals of the Siemens-IBM-Toshiba cooperation silicon-based microelectronics has not reached its industrially usable limits by far. The mesoscopic systems, meaning the transition region between the massive solid state and the nuclear or molecular area, will form the basis for the next segment of electronics—here called nanoelectronics. Here, in contrast to microelectronics, quantum mechanical effects are utilized which at normal temperatures occur only in extremely small structures of the highest crystalline perfection in the range below 100 nanometers. The "nanoelectronics" thus outlined, which could be based on both silicon and on gallium-arsenide, may possibly lead to the first important applications in industry as early as the end of this or the beginning of the next decade. Nanoelectronics is described in detail in Section 4.2.2.

4.1.2 The JESSI Program

The JESSI program represents a completely new type of research program. It is not a sum of parallel individual activities, but the integration of various activities into a strategically oriented overall concept under the leadership of the European microelectronics industry. This is reflected in the selection and structure of the JESSI projects.

Even a large, joint research and development program cannot get involved in all relevant areas. For this reason particularly important projects, so-called flagships, have

been defined by the industry, which combine the contributions necessary for the research work under one organizational framework. The principal attention is here directed toward rapid exchange of information between the partners involved. The contents of the "flagships" in the application area are oriented toward products which based on today's view, will reach major market significance at the end of the 1990s.

With the advance of microelectronic circuits into increasingly larger application fields, the demands for the reliability of such circuits are growing, for example when they are used in motor vehicles or in aircraft. Microelectronic circuits for new application areas must still work reliably in rough environments at increasingly extreme temperatures and control higher and higher electrical outputs. Also, the automobile industry, being one of the most important industries in Europe, must be supplied with the required microelectronics in order to be able to maintain the European producers' market share in the long term. Broad application of the possibilities of microelectronics ranging all the way from small and medium sized industrial enterprises is a primary task in order to safeguard the European industrial structure.

Although the application fields for microelectronics described so far cover many different areas, there is a multitude of common problems, the solution of which has the precondition for attaining the specific goals. The JESSI organization has taken this into account with the restructuring of the program proposed in October 1991.

The projects can be divided into two categories:

1) expansion of the Technological Base

- methods and tools for circuit design
- Manufacturing techniques for integrated circuits

2) Future-Oriented, Application-Related System Solutions in Hard and Software, Integrated on One Chip

- digital radio (DAB)
- mobile telephony
- high-resolution television (HDTV)
- security-optimized application-specific IC's for the motor vehicle field

In the first group the consortia work with preferably horizontal cooperation. In general, the result of this forms the basis for more vertically structured joint projects by IC manufacturers and users of the second group.

4.1.3 Methods and Tools for Circuit Design

The computer-supported design systems for IC's or further-ranging complete CAD systems which can be obtained on the market today suffer from the lack of compatibility with the individual software packages, which have to be used at the various levels of system design. In principle this applies also to the transition from the design of automatic control engineering

behavior to chip design. With a design system called "CAD frame" the European CAD users and suppliers wanted to offer the engineer a working environment which permits him to influence various abstraction levels of the design in a specific way (all the way from chip layout to the spatial arrangements of functional blocks, if possible on the printed circuit board level) and which gives him the freedom to integrate special design tools for his needs into the design system. This presumes an "open" structure. Open here means that the user can supplement his planned application selectively with his own software packages. The data administration of such a design environment must be subject to certain standards ("standardized interfaces") so that at the various abstraction levels of a circuit design individual, company-specific software can be integrated without expensive adaptation.

In contrast to the CAD systems of today, which at a very early point lock the user's design into a certain technology and thus to one IC manufacturer ("closed systems"), the selection of technology must not take place until a low abstraction level. This has the advantage that the systems knowledge remains as long as possible with the user and the most suitable technology can be chosen at an advanced design stage. A desirable side effect is the standardization of the command sequences, with which the development engineer operates the design system.

This standardization, combined with a simple adaptation of the user's needs, makes it easier, particularly for smaller companies, to use microelectronics in their products.

4.1.4 Production Techniques

In order to remain competitive on the world market today, the production of highly integrated semiconductor components must meet in part contradicting requirements. Thus, the pressure toward constantly lower production costs through mass manufacture can be met with more efficient production methods. However, application-specific integrated circuits (ASICs) must be able to adapt themselves flexibly to the demands of end products and be produced for them. Here there is also a demand for flexible production methods, which must simultaneously be economical. An answer to these different requirements is the greatest possible automation of the manufacturing processes. Automated processes deliver high yields and can be adapted to rapidly changing operations. In order to put together a specific semiconductor production line from automated process modules, compatible standards must permit the combination of different equipment blocks. Here, JESSI projects for the first time include many European enterprises, so as from the outset to avoid the previous development of nothing but individual island solutions in the production process. On the contrary: from the beginning a flexible and largely automated semiconductor manufacturing process is to be developed, based on European know-how, which cannot be synonymous

with a standardized European CMOS [Complementary Metal-Oxide Semiconductor] process, however.

In order to be competitive worldwide, the semiconductor production methods must utilize the most recently available technologies. This requires the integration of methods to process silicon wafers with larger diameters, the use of new metallization and etching operations as well as the development of new and extremely pure materials. The JESSI cooperation is intended to assure that the individual success will simultaneously benefit the entire European microelectronics industry and that, consequently, a broad basis of reasonably priced European suppliers will be available for user industries.

The JESSI program supports targeted developments, which permit the circumvention of current technological bottlenecks and which significantly accelerate practical implementation of foreseeable technology developments. One fundamental problem in today's production of constantly more miniaturized circuits is error-free lithographic reproduction of tiny circuit dimensions across expanded semiconductor chip surfaces. One foreseeable consequence of the progressing higher integration is that the smallest structures necessarily become smaller than the wavelength of visible light. Known photographic reproduction methods therefore need to be further developed in order to open up possibilities for using even shorter wavelengths (deep ultraviolet) and techniques which take the phase relationships of light (phase contrast) into account in image formation. Here a special JESSI project is beginning, headed by a semiconductor manufacturer in Germany. What is crucial for the goal of this project is that the lithography technique developed in JESSI is being tested early on in semiconductor manufacture and is thus qualified for use in the production of various semiconductor manufacturers. This is where the bundling of developments under JESSI is therefore aimed particularly at accelerating the conversion of physically known methods into production-relevant procedures.

The highly automated manufacture of integrated circuits implies special burdens for the workforce (such as concentration and isolation). In order to reduce these specific burdens, comprehensive improvements are necessary by means of arranging the work organization and techniques. Here as well the increasing problem of the degree of automation, the so-called "residual jobs," must be solved. Such projects can be funded under the BMFT's Work and Technology Program.

Support for Small and Medium-Sized Companies

Particularly for medium-sized companies a problem results from the fact that when using specific microelectronic components a portion of the production depth and thus the systems knowledge shifts from equipment or system manufacturers to the component manufacturers, who may possibly produce competing products in their own group and sell on the world market. This danger exists particularly with respect to the Far East

competition, when equipment and systems producers do not learn how they themselves can without foreign help transfer their knowledge to chips with the most recent technology. The entire user industry as far down as the medium-sized level is affected by this, for example in the area of measurement, control and drive technology. In order to address this concern a special project was created to stimulate the medium-sized businesses to utilize microelectronics to a higher degree and to raise their competitiveness by using the results gained under JESSI. Within the framework of this project, demonstration centers are being established at existing institutions in the FRG and put to use according to their background of experience. By arranging information events, seminars and courses the users are gradually introduced to the JESSI technology and modern design methods for highly integrated systems.

In addition to the work started under JESSI, the Federal Government supports further measures to strengthen knowledge about the use of microelectronics in Germany and to include as many potential users as possible. The senate of the Fraunhofer Society has thus decided to reestablish the Institute for Silicon Technology (ISiT) in Itzehoe. The focal points of the work program will be to develop technologies for highly integrated, application-specific circuits (ASICs) and microsystems technology based on silicon. The work includes contributions to the manufacturing technology. It will take place in early and close contact with industry. The work program will be started at the beginning of 1993 at the Institute for Microstructure Technology (IMT) in Berlin. The IMT will then be renamed ISiT-Berlin and after completion of the buildings in Itzehoe move there.

Another contribution to the application of microelectronics is being made by several institutions participating in a north German network. Through this network, consisting of SICAN in Hannover (Silizium-Anwendung und CAD/CAT Niedersachsen), the Institute for Applied Microelectronics (IAM) in Braunschweig and the Microelectronics Application Center (MAZ) in Hamburg, an infrastructure is being made available with which the R&D capacities—such as are offered for example at the academic institutions in the vicinity—will be bundled and strengthened as well as networked with the industrial microelectronics users. The network's concentration therefore lies in supplying advanced engineering and other technical services which are not available or available in a suitable form on the market.

This promotes application of microelectronics, particularly in medium-sized enterprises, by means of carrying out joint projects based on the industrial standard, which are supplemented by pioneering research activities including information, advice and middleman activities. In particular the problems that must be solved in the area of operating funds, artificial intelligence systems for production and order management by users in the small and medium-sized business sector can be reduced through people-friendly design measures such as in the

necessary software, the communications interfaces and the flow of information. Here one may expect direct competitive advantages from the comprehensive layout in the sense of the goals of the Work and Technology program (see also Chapter 4.6).

The network model of the MAZ in Hamburg, IAM in Brunswick and SICAN in Hannover permits the coordination of various tasks without therefore depriving the individual facilities of the opportunity specifically to look after the needs of their group of interested parties.

In association with a few other institutes, particularly from the Fraunhofer Society, an offer is therefore available, spread across the entire FRG, to increase the breadth of impact of microelectronics application. The intent is to reinforce the already existing attempts for this in the new laender.

From the former Microelectronics Combine in the eastern part of the FRG well-trained personnel is available for the entire field of microelectronics, so that the personnel bottlenecks often complained of in this sector can clearly be alleviated. For the same reason the BMFT financed a training program as early as the 1980s, in which students were highly trained in the design of integrated circuits (E.I.S. project). The EC Commission has taken up this project and is continuing it as the Eurochip Project within the European framework.

4.2 New Materials and Technologies

The strongly expanding application fields in information technology, in which extreme speed, the highest frequencies or the combination of electronics and photonics are becoming increasingly more important, require the development of new basic technologies in addition to the silicon technology. For this purpose the compound semiconductors such as gallium arsenide and indium phosphide have proven themselves, and using them could become a prerequisite for solving public problems.

—Monitoring Environmental Pollution. The major increase in air pollution from auto and industrial emissions (such as CO₂, SO₂, nitrogen oxides, ozone, etc.) needs the construction of powerful information-technical systems to detect these gases. In order to produce these information-technical systems with improved detection limits, components such as semiconductor laser diodes, low-noise amplifiers and detectors based on materials from compound semiconductors are important technological innovations.

—Increasing Traffic Safety. The traffic density on the German autobahns continues to grow due to the annual increase in new licenses for motor vehicles and to the opening of the eastern European borders. In air traffic as well we are seeing an increase in traffic density.

By using modern and highly developed information and communications technology systems the risk of accidents in air and highway traffic can be substantially reduced. Among them are traffic control systems which

in every traffic situation contribute to the best decisions on the route and lead to straightening out the traffic flows. Radar systems, which constantly monitor the distance to the vehicle in front and in case of danger or with an insufficiently safe distance warn the driver through a signal, further increase safety in highway traffic. Fast transmission systems for redundant, central control systems permit analysis of and influence on far-reaching traffic flows

For such systems electrical and optical components such as semiconductor laser diodes, detectors and microwave circuits based on the materials gallium arsenide and indium phosphide are indispensable, since silicon technology comes up against its physical limits here.

—Image Processing in Medicine. The use of modern, highly developed equipment in medical technology, such as in image-taking and image-processing, results in more extensive and faster diagnosis of people's medical condition. For real-time processing of the considerable amounts of data collected in this field, caused by the high-resolution image technique, the development and use of transmission systems with high bit rates are necessary. Components such as semiconductor laser diodes and detectors of compound semiconductors represent a prerequisite for this. Display techniques must be developed for high-resolution image technology.

The following concentrations are therefore of primary importance for the funding:

4.2.1 Microelectronics Based on III-V Semiconductors

Electronic and optoelectronic components from the III-V compound semiconductors such as gallium arsenide (GaAs) and indium phosphide (InP) display three advantages over silicon components: They switch faster with lower energy requirements, they enable components for higher frequencies and they can receive and emit light—a property which finds multiple applications in optoelectronic systems. Components of gallium arsenide and indium phosphide will, on the one hand, find their application and be utilized instead of silicon components in places where the point is to realize information-technical systems with the highest transmission capacity. These are, for example, superfast computers, navigation systems with millimeter waves, distance warning radar for cars or fast information transmission systems and communications technologies. On the other hand, III-V semiconductors represent the basic technology for optoelectronics and photonics, which are described in more detail in Section 4.2.5.

Compared to silicon, the III-V semiconductor technology still has a considerable lag in development and is therefore only at the beginning of its commercialization. That is also understandable, since these materials can only be produced with extremely costly methods in the necessary purity and crystal perfection. Accordingly, compared to silicon a significantly more complex process technology is also required in order to arrive at an

economically favorable production of highly integrated circuits. In this respect there is still a considerable need for research and development expenditure.

Based on the already developed, highly complex facilities and methods in GaAs and InP technology, it has further been possible to reduce the thickness of the individual layers of components to such an extent that layer sequences can be produced in a controlled manner from a few atomic layers, in which quantum-physical effects with new kinds of principles of function for components are possible.

This problem definition is central to the research network for compound semiconductor technology supported by the BMFT and will be described in the following as a part of nanoelectronics.

Nanoelectronics

The precision methods created in microelectronics have been developed so far that structures below 100 nm all the way to a few atomic layers can be produced in a controlled way. In such structures conventional description of the movement of electronics fails; the wave properties of the electron make themselves increasingly noticeable. When the development of electronic components penetrates into this area—also called the mesoscopic—it is necessary to take newer quantum-physical effects into account. Examples of this are the quantum mechanical tunnelling effect or quantization effects necessitated by size. Thus, an electron is capable with a certain probability of tunneling through a thin insulating barrier; according to the concepts of classical physics, on the other hand, it would be impossible to overcome such a barrier.

However, the additional quantum effects can also cause problems for component technologies employed until now, but they offer an opportunity to design completely new elements of function. Such nanoelectronics differ from today's technology not only in quantity because of the advance to still smaller structures, but also in quality, through the use of new quantum-physical effects.

Sharply limited transitions in the semiconductor structures are required for the appearance of these effects. So far particularly III-V compound semiconductors such as gallium arsenide have proven themselves. With defined production of various samples it is possible to make an exact comparison with the statements of the theory.

These advantages have had the effect that basic research, as well as research aimed at application, has so far been primarily conducted in the III-V technique. In suitably structured components it is possible, for example, for electrons to move without scattering in the crystal lattice. With such semiconductor structures so-called ballistic transistors can be produced, which permit a very much higher switching speed than conventional transistors.

Electronic components with mesoscopically small structural dimensions based on GaAs are already reality in

today's laboratory. But basic research is still needed to a considerable extent in order better to understand the physical effects and also to master them technologically. Above all, special methods of process technology must be developed in order to manufacture these components as discrete components or to integrate them monolithically into circuits. The application spectrum ranges far beyond the production of transistors.

For broad industrial applications of nanoelectronics the question of whether systems can be developed which are compatible with the established silicon technology is important. The electronics that depend on new physical principles will also be embedded in a periphery of conventionally integrated silicon technology. Transitions to silicon which are produced through diffusion, for example, are not suitable for vertical nanostructures, to be sure, because they are not sharply enough defined.

At present the material combination of silicon-germanium (SiGe) appears more promising. One example of a component with SiGe technology is the hetero-bipolar transistor. The first laboratory models are already able to compete with the switching speed of GaAs transistors.

These components fall below lateral geometries of about 100 nm and vertical structures of about 10 nm. In the experimental realization of these extremely fine structures, epitaxy dominates for the layer structuring, while laterally the structures are usually made by means of electron beam methods.

The extremely high mobilities and the resulting high switching speeds or frequencies that can be achieved permit the expectation of interesting applications in high-frequency technology. The high integration density possible is also of interest to the further development of rapid digital circuits.

The BMFT's support is concentrated to the basic research that is still needed to a large extent, and it must further search out those options which open up the knowledge from basic research to the application of nanoelectronics. It must be clarified whether potential advantages compared to today's technology can also be realized under the framework conditions of technical production as well as application. This requires research and development in the transitional region from basic research to application-oriented research.

4.2.3 Molecular Electronics

Through a continuous increase in the degree of integration with extremely small structures, it appears possible that even gigabit memories can still be produced in silicon microelectronics. For memory densities above that, molecular electronics could be considered.

The electronic and optical properties of molecules from carbon compounds can be used for a variety of purposes in molecular electronics. Among them are memories, switches, molecular diodes, transistors and electrical

connections. The existence of these molecules in distinguishable conditions can be utilized for memory applications. The dimensions of the molecular memory can be about 1,000 times smaller than conventional silicon memories. Since molecular memories can also be arranged in three-dimensional ways, the result is a memory density which could be up to six orders of magnitude (one million times) above conventional memory densities.

The development of molecular electronic components is still in its infancy. Components made from organic molecules are so far only being achieved in individual cases. Since the specific electrical and optical approach to the individual molecules has not yet been determined, the work in molecular electronics will initially be limited to basic research. In this concentration two joint projects are being supported, which deal with the production and definition of the material systems and the first potential applications, such as memories.

4.2.4 High-Temperature Superconducting

A few years ago the discovery of the ceramic high-temperature superconductor, with application possibilities at the temperature of liquid nitrogen (-196 °C), spurred new research efforts all over the world. Based on this opportunity, the future development of superconducting components in sensors, microelectronics and high-frequency technology must be reevaluated.

Superconducting systems, which are faster, more compact and economical than previous ones, now appear technically feasible. From today's aspect these new, special properties of the high-temperature superconductors allow us to expect many applications in microelectronics.

For example, superconducting layers on silicon or gallium arsenide substrates could be used to increase the transmission speed between semiconductor chips or enable highly dense wiring on chips.

In order to work out these technological foundations for information technology and make them useful for new applications, a joint project called "First Applications of High-Temperature Superconductivity in Microelectronics" has been started within the BMFT's high-temperature superconductivity program.

4.2.5 Photonics

By the relatively new concept of "photonics" is meant the transmission and processing of information with optical and optoelectronic means. While in electronics the transmission and processing of information takes place on an electronic basis, meaning with electrons, in photonics photons, that is to say light quanta are used as information carriers. In contrast to electrons, photons do not interact strongly with one another. This property, and the clearly higher transmission capability of optical channels, contributes decisively to the clear superiority of optical transmission in comparison with electrical transmission methods. Photonics must be regarded as a

basic new technology for information transmission and processing and in the future could achieve the same significance for information technology as microelectronics has today.

The development of electronics into photonics is based on progress with III-V semiconductors such as gallium arsenide and indium phosphide. Additional important materials that are gaining importance in this field are polymers for waveguides as well as for active components. These materials and material systems make an integration of electronic circuits and optoelectronics as well as optical components possible, so that electrons and photons would be used in an advantageous combination for carrying information.

One of the most important application fields for photonics is optical communications technology. In electrical communications technology interference effects, such as crosstalk and echoes at high data speeds (after about 100 Mbit/s), cause major problems and make the development of extremely rapid information technology systems difficult. Since photons, in contrast to electrons, cannot interact with one another, optical communications technology can bring a crucial breakthrough for the solution of these problems. Due to the special properties of photons there is also the possibility of realizing numerous independent beam combinations, including those that cross, in the smallest space. With this new degree of freedom optical communications technology becomes a very promising alternative to conventional communications technology, particularly in highly complex electronic systems.

The transmission of information with photons has already become established in beam waveguide technology and proved its economical use above all in telecommunications. In addition to cable-bound transmission of optical signals, they can also be sent through empty space to connect two points. By using appropriate imaging optics, several recipients can be reached at the same time.

The optical signals made by connecting individual components in these complex systems require appropriate signal processing. Here the light signals, for example for switching processes (transmission), must usually be converted many times after one another into electrical and again into optical signals. Each optoelectronic conversion represents a bottleneck which reduces transmission speed. With optical signal processing the goal is therefore to make switches and other functions optical, in order to get components that use nothing but optical signal paths. Due to the extremely high transmission capacity of optical paths and the opportunity for high-grade parallel processing (one lens processes the information of an image in parallel with the speed of light), the construction of very powerful signal processing systems is expected. As a distant goal, an optical computer is conceivable in which a large number of processors are connected through optical communications networks,

and where through massive parallel functions significantly higher computing power can be achieved than with today's supercomputers. The extent to which such expectations can be met must be clarified within the framework of research and development projects. Optical signal processing is therefore the object of research and development programs all over the world, particularly in Japan and the United States.

In the funding program called Photonics scientists from industry, research institutes and universities are working closely together on two joint projects in the fields of Optical Communications Technology and Optical Signal Processing. The goal of the R&D work is to research the potential of photonics and to demonstrate it by way of selected experimental systems. In so doing a series of fundamental problems must still be solved. The development of key components based on III-V semiconductors, such as surface-emitting laser diodes, optical switches, optical amplifiers, photodetectors and modulators is also part of this, as is the development of optical multichannel short distance communications systems and new kinds of optical bus systems.

Not until this fundamental research and development work has been completed and the various functions have been demonstrated in practical experiments will additional developments be possible, which today may still be regarded as utopian. With the help of photonics, for example, networks could be created which in function and structure come closer to the nervous system than can be imagined on a conventional, electronic basis.

Optical neural networks is the key word for a new phase throughout information technology; photonics is the basic technology for that. Such thinking will not become reality without progress in the many partial technological areas mentioned. Only a gradual development, building on definite knowledge, will lead further. An abrupt change from electronics to photonics is not the goal, but intelligent combination of the advantages of electronics with the new degrees of freedom of optics must be regarded as the key to success in this field.

4.2.6 Display Technology

A significant key element in servicing information systems and machinery in addition to the computer is the display screen. This is what enables a user to obtain access to the information technology system. Examples of this are text processing, bank terminals, displays in aircraft and in the car. In the field of communications technology the following applications are now in use or at present being studied: Portable televisions, flat screens, HDTV, video telephone, information systems and medical information systems.

The most widespread cathode ray tubes today are out of the question for the new applications because of their large size, weight, the electrical power needed and the high-voltage supply. A completely new generation of flat

screens, such as are already being used today in tiny televisions or in laptop computers, must be developed for future applications.

Many technological problems with the flat screen have not yet been satisfactorily solved. But it is already possible to discern that the flat screen will represent one of the most important future markets in information technology. The Japanese industry, led by the Ministry for International Trade and Industry (MITI), recognized the strategic importance of the flat screen early on. The development of a flat screen with the size of about one square meter is being carried out within the framework of a state-subsidized program. In contrast, the European industry still needs to make efforts to bring about a corresponding EUREKA project.

The screens manufactured with LCD technology must be able to compete with conventional picture tubes with respect to gray-scale resolution, color rendition, image-changing frequency, number of pixels and lifetime. The first equipment made in Japanese research laboratories has already achieved this with a picture screen up to 36 centimeters on the diagonal. For larger diagonals up to one meter, however, considerable research and development expenditures are necessary. Fundamental work still needs to be done in researching suitable liquid crystal materials and their use in coating glass substrates, aging and electrical selection.

The BMFT's support is concentrated on research work on electrical luminescent screens, principally liquid crystal displays (LCD), with new types of liquid crystal materials. For this purpose the initiative of the land of Baden-Wuerttemberg for the establishment of a laboratory for videoseen technology at the Institute for Network and Systems Technology of Stuttgart University was supported by the BMFT.

In recent years this institute has developed into a talent center in the FRG in the field of liquid crystal videoseen technology.

Information Science

Information science is the theoretical, experimental and structural science of information systems, their programming and possibilities for application. It was and is a rapidly growing field of science with major innovative force. In less than three decades it has developed from a small scientific seed into a crucial and, for large parts of our economy and society, important factor. It has now become a basic and interdisciplinary field for most developments in science and research, in education, in the economy, technology, public administration, yes, even in the private area, meaning in our entire community. It depends primarily on its research results and their implementation in practical life whether the research results of other disciplines can be converted into useful applications.

Information science research in the FRG, with all of its important application orientations, enjoys a high international reputation, for which, to a significant extent, it can thank the emphatic research support from the BMFT and DFG in earlier years. It is the declared goal for the future BMFT support as well to maintain and expand this research location.

The focal points for information science funding have shifted in the last few years. The center of the funding interest is now the tools and software for opening up new applications for conventional and new computer structures and no longer the development of the computers themselves. Software is gaining an increasingly important rank in the workplace as well, as a technology on a plane above the industries. It influences the productivity and flexibility of all economic areas to a growing extent and thus the working conditions of most working people.

A new concentration for support is bioinformation science [or bioinformation science, in which knowledge from biological systems is to be converted into information-technical systems. Here the already established neuroinformation science ranks first. The methods of artificial intelligence, language recognition and language translation are current fields of funding.

One major challenge, with considerable economic impact, lies in the foreseeable availability of super-parallel computers up to the tera-flops range and in their efficient utilization. New mathematical and algorithmic methods for parallelization of the applications and visualization tools for interactive simulations are needed. These activities are summed up under Supercomputing (see Section 4.3.3).

The Reliability of Information Systems is gaining increasing importance as an interdisciplinary task. The relevance of this set of topics is shown in the public discussion on the "correctness of software," "reliability of information systems" and "protection against manipulation," as well as on "computer viruses."

All of these funding concentrations are of eminent importance for the further development of application prospects such as (see Chapter 3):

- Computer-supported development, manufacture and logistics in all branches of the producing economy
- medicine and an economical health system that corresponds with an international standard of quality
- environment and environmental protection
- a safe and environmentally compatible transportation system
- building a bridge between biology and information technology, particularly with respect to applications in biology and chemistry
- shaping the increasingly more clearly evident "networked (informed) society," with its growing demands for quality and security in information processing and communications.

4.3.1 Applications of Artificial Intelligence, Leading Projects

The concept of Kuenstliche Intelligenz in German linguistic usage is a direct translation of the name Artificial Intelligence introduced in 1956 by U.S. researchers. It was intended to describe a new field whose goals were to be machine understanding of human intellectual performance. In the meantime, it has become obvious that at the core of the ensuing questions the processing of knowledge by computer is a continuation of the previous processing of data by computer. This opens up three fundamental areas of activity:

- The acquisition of application-specific professional knowledge (acquisition of knowledge).
- The formal representation of knowledge (knowledge representation).
- The deduction of conclusions (knowledge processing).

While the previously developed expert systems have now experienced increasing application in the economy, machine learning is beginning to emerge for the future integration of artificial intelligence methods into complex problems solution systems and in combination with neuroinformation science.

Here the research is concentrated to the following fields:

Knowledge-Based Systems

Such systems should be capable of:

- linking expert knowledge with problem-specific data
- dealing with incompletely described circumstances
- asking for missing data in a specific way or making sensible assumptions about them
- explaining the courses of action and motivating them.

Special technical requirements in this area are the acquisition of knowledge all the way to automatic knowledge acquisition, knowledge representations in the system and advanced mechanisms for conclusion. To these are also added questions of human-machine interface, distributed architectures for knowledge-processing systems as well as the coupling to conventional data-processing systems.

Knowledge-based systems are at present supported by the BMFT as a concentration at the German Research Center for Artificial Intelligence (DFKI).

An important field of application for knowledge-based systems will in the future be the workplace. Such systems can make an important contribution to the support of complex activities. One priority here—as required in the report of the Expert Systems Inquiry Commission—is to study within the Work and Technology Program how, on the one hand, the potentials of human expert knowledge can be better used and, on the other, experts can be assisted by new systems in their previous activity or for expanded tasks (skilled).

Recognition and Interpretation of Moving Images

This research field involves interpretation of image sequences and moving scenes with the help of artificial intelligence methods. With this it is possible to study, for example, how the driver of a vehicle can be assisted by machine interpretation of the road condition and warned in critical situations. This is based on the argument that the majority of serious accidents would be avoidable if the driver had reacted only fractions of a second earlier.

Traffic safety and traffic control can become an important application field for artificial intelligence in future years, because they add new, more intelligent qualities to the well-known solutions.

Language Recognition

The need for machines to understand and process language has essentially two reasons:

- the use of language for simpler communication between human and machine (such as in information systems)
- machine language translation.

Computer processing of spoken language is a particularly difficult problem, to be sure, perhaps the most difficult of all in information science and linguistics. Language is very dependent on the speaker in pronunciation and expression, frequently vague in content and depends on the context for its meaning. It is partly redundant, and often greatly abbreviated. In order to be able to recognize, understand or translate entire sentences, several processing and information steps must be passed at the acoustical, phonetic, syntactical and semantic levels. Largely error-free language recognition requires the immediate cooperation of all levels.

A wrong word does not become noticeable until in the sentence, and a meaningless sentence only becomes apparent on the semantic level. This interlinking of several processing levels is being studied in a joint project (ASL, new Architectures of Speech-Language Systems), in which techniques for recognition of the spoken word (speech) and processing of the content of written language (language) in an integrated architecture are being further developed.

The problem of language recognition is also being tackled under the Work and Technology program. Here there are initial studies, in the sense of evaluating technological results, of successful pilot applications with respect to potential stresses, changes in work content, the work procedure, integration into the operation and human-machine interfaces and requirements for design.

Language Translation

A precondition for machine translation of spoken language into another is the recognition and correct interpretation of the language input. The translation system further needs for the sentences of the original language to

be present in a computer-internal representation including explanations of their meaning, in order to be able to transfer them meaningfully into the end language. The way in which this machine operation should appear to the human user is a question of interpretation process and acceptance research which must still be even more thoroughly researched.

Translation systems are large software packages which require enormous computing power. Simultaneous translation equipment in pocket format is not yet technically feasible today or in the near future. That is the very reason, however, that they are a challenging and rewarding long-term task for specific basic research.

The technical progress achievable elsewhere (such as in computer architectures, processors and memories) should lead to implementation, after clarification and demonstration of the fundamental principles, in the form of a mobile translation system. A new master project called VERB-MOBIL is already being funded, which is working toward such a mobile translation system for spoken German language as a future vision. Linguists and information scientists—in particular from the fields of artificial intelligence and neuroinformation science—are to work together on this.

4.3.2 Bioinformation Science, Neuroinformation Science

With the transition from classical, sequential information processing to (fine-grained) distributed and parallel storage and processing of information in neural networks is combined the special ability of data-based learning and remembering and the possibility of associative supplementation of partial information through knowledge that is present in the system. Such flexible and adaptive systems are modeled on nature. They have the greatest prospects for application.

In 1988 the BMFT began to support research work aimed at transferring principles of information processing in biology to technical information science. The result was the basic, research-oriented joint Information Processing in Neural Architecture (INA) project. It is based on the hope that a technically adequate solution can be found for a series of tasks which require associative or learning capabilities and occur primarily in the fields of image processing, language recognition and motor control.

Meanwhile, with the help of research cooperations it has been possible to establish efficient working groups at academic institutions, to bring about close working contacts between people and to achieve significant goals in the first phase.

The second funding phase which has been under way since 1991 involves researching and developing systems that investigate their natural surroundings and can act in it. These systems are to orient themselves with various sensors and be able to react to language input. For this the systems must to a certain extent be capable of

independent learning. The principal theme thus combines the problem formulations of sensors (recognition of language and images) with those of motor skills (movement coordination).

Bioinformation Science

Bioinformation science, in expanding the beginnings of neuroinformation science, involves interdisciplinary integration and cooperation on questions of biology and information science, and primarily:

- Developments of new memory, transportation and processing systems in information science (further development of neural networks, development of self-organizing technical systems from the analysis of self-organizing biological systems, new visualization techniques, etc.), which are derived from the knowledge of biology
- goal-oriented new development of information and mathematical methods and techniques for processing unsolved problems in biotechnology (such as development of special parallel algorithms for biological data bases, development of special knowledge-based systems for the analysis of proteins, etc.).

This can be explained using the following two examples

For the development of biotechnology, the decoding of the entire genetic information of living things is of major importance. Over the next 10 to 15 years it is to be explored in detail for individual cases, according to the plans for various international genome research programs. The anticipated enormous increase in genetic sequential and structural data reinforces the already evident imbalance between data quantity and data processing. Here, on the one hand, the development of new methods of data gathering and administration is needed, and, on the other, new approaches to the interpretation of the data must be found.

Protein design demands new mathematical and information methods. The application potential of proteins which have been deliberately equipped with new properties cannot be overestimated. In this context one can merely point to the development of bioreactors, the decrease of harmful substances, new drugs and vaccines as well as biosensors. Precisely in protein design, however, the present simulation methods come up against their limits due to the size of the molecules involved and the complexity of the relevant interactions with respect to their computing speed and graphic representational speed. New algorithms and computer techniques, which transfer the principles of the multigrid methods so successful in technical simulation to the problems of protein design, must be developed.

Analogous reflections can be made for a whole series of scientific disciplines. In the following section they will be described under the concept of supercomputing.

Supercomputing

Supercomputing, that is to say the treatment and solution of complex scientific and technical problems by mathematical modelling and simulation using supercomputers, is awarded the rank of an independent scientific method. Over the next decade computer development will be marked by massively parallel systems with tens of thousands of processors. This kind of computer promises a leap in power from 100 to 1,000 (teraflops computers) compared to today's vector computers (or fields of work stations). Science and, in particular, the economy will profit considerably from these developments, since expensive experiments will largely be replaced by interactive simulations.

While the corresponding hardware developments are progressing quickly and with a great deal of promise for success, there is a substantial need to catch up in R&D in the software sector, especially in the area of application software.

The application prospects for teraflops computers in materials research, in flow and turbulence research, in molecular chemistry, in biotechnology, in pharmaceuticals, in weather prediction and in climate research are so important, that the economic gains from later application of such computer systems are likely to far outweigh the R&D expenditure now involved.

In addition to the application areas mentioned, the development of parallel computer technology will have significant impact on industrial applications even in the short run, above all in the real-time area, as for example in industrial control (particularly for robot control), in machine understanding of image and speech, in automobile electronics, etc.

It is foreseeable that in the abovementioned fields in the future nearly all experimental solutions can be replaced by:

- new, high-resolution modelling
- algorithmization and programming for massively parallel computers
- interactive simulation with real-time visualization in these computers.

According to today's findings, with respect to application, modelling, parallel algorithms and parallel programming, the potential is there for increasing the performance similar to the hardware development of the supercomputers themselves.

Close interdisciplinary cooperation between the basic sciences of:

- mathematics: for the development of new parallel solution attempts
- information science: for offering architectures, methods and tools for efficient and secure implementation of parallel algorithms
- the application sciences is thus indispensable.

In the coming years the BMFT intends to fund key method problems in supercomputing by means of concrete application questions. In so doing it presumes that highly parallel supercomputers up to the tera-flops region can be made available by the industry in the next few years without national subsidies.

The BMFT's funding concentrations are, in agreement with other programs (EC, laender, DFG) in the following areas:

- Tools for converting existing application software to the new, parallel systems, which permit rapid and economical conversion even of extensive program packages.
- Tools for developing application software for parallel computers, flexibly manageable tools to support all drafting phases from specification and verification, through mapping, fault search, performance indications and visualization, all the way to runtime support using dynamic load equalization mechanisms.
- Development of standardized programming interfaces, which assure the portability of application software between systems of different configuration and between different parallel computer architectures.
- Rapid parallel algorithms for supercomputers, for example in real-time simulation of applications with supercomputers.
- Reliable and secure supercomputer connections, with a transmission speed of up to the Gbit/s range, at affordable prices.

The BMFT will describe the individual subsidy measures and the overall framework once more in a detailed special pamphlet.

4.3.4 Reliable Information Systems

Almost all areas in the economy and administration today depend directly or indirectly on the functioning of information processing. The breakdown of a computer, errors in a data processing program or the loss or manipulation of data can bring complete production or administrative sectors to a standstill and cause widespread damage as a result. The individual citizen is also affected when personal data are manipulated or spied on.

Funding security and reliability in information processing is therefore a task for the government's role of caring for our well-being. Here the BMFT and the Federal Office for Security in Information Technology (BSI) are working together and supplementing each other. The BSI is charged with developing methods and tools for testing the security of information technology systems and components. After appropriate evaluation, it issues security certificates. The BMFT supports the preceding research work and developments in information science as a concentration with the goal of reliability against manipulation attempts and correctness of the programs produced (quality assurance for software).

The BMFT's research support is initially concentrated to the two leading projects REMO and KORSO.

The joint Reference Model For Secure Information Technology Systems project (REMO) has two R&D approaches:

In the constructive approach, today's functions and communications paths in a computer system will be deregulated and redefined under the aspects of security. The result is to be a formal description, a "reference model for secure systems," supplemented by a guideline for future developments of information systems, taking their technical and organizational environment into account. To begin with, the performance goal for this is intentionally and deliberately of less importance than the security.

A second, topical approach in REMO (supplementary approach) is being taken for the widespread use of PC systems and workstation computers in order to improve the security situation faster. The attempt here is to add security mechanisms which can be retrofitted to the existing technical interfaces. For example, a user interface supplied by the manufacturer can be replaced by another which no longer permits access to all functions of the information system. This way it is possible to prevent circumvention of the built-in safety measures.

In the joint Correct Software program (KORSO) the instruments of the specification languages and the machine proofs can be connected with one another. Based on the task specifications, a data processing program is to be gradually more finely defined until ultimately the actual program code is obtained. Each individual step is thereby to be tested with the help of proof algorithms with respect to its formal correctness. The final conclusion is:

- When the output specification precisely and completely describes the task to be solved
- when the development steps derived from it have been individually proved by machine to be formally correct
- the result, that is to say the program code, will also be correct.

This project is thus an important step in the field of quality assurance for software.

4.3.5 Software Technology

Both past and foreseeable developments unequivocally indicate that software—to an even greater extent than hardware—will continue to gain importance and become a dominant economic factor. It occupies a special key position as a basic technology, on which the development of many other fields—not only information science—are directly dependent. Despite the successful work within the framework of previous subsidy programs, numerous fundamental problems have not yet been solved in useful form, or new questions have been added. In this context one might mention specification,

portability, reusability and modifiability, and the organization of complex, distributed software systems, as well as questions of machine verification.

In all, the focal point of future R&D tasks lies in mastering the complexity of integrated overall software.

Design and Testing of Reliable Complex Overall Systems

Support for the design of reliable overall systems (technical components plus software) is an important concentration for future research. Since computer systems are increasingly being centrally used for critical applications, it is necessary to guarantee as early as the design stage certain important properties such as operational security, security against catastrophic errors, robustness against breakdowns, ease of testing and ease of altering. Corresponding tools for the specification, design and implementation, as well as for performance measurement and machine verification, with simultaneous documentation and quality assurance must be developed, or the existing attempts must be integrated and tested.

Reduction of the Program Steps

In order to master the overflowing complexity of large software systems with millions of lines of code, the software must be designed in significantly more modular form than before, which also increases reusability. Reducing the number of coding lines to be created and controlled by the programmer must be further advanced through new, usually object-oriented programming languages.

Software Reusability and Software Reengineering

A basic problem in the economy is the constantly required adjustment of existing software packages to new tasks or framework conditions and software reusability in the development process. In this context, questions of documentation of reusable software, the adaptation of software to current applications and methods, tools and techniques for software reengineering are assigned major importance. So far there has been only a small number of method foundations and research projects in these subjects.

Software Factory Master Project

An important part of the R&D work in software technology is already being done in the current EUREKA Software Factory project (ESF).

The goal of this project is to improve the foundations for industrial-scale software production and to standardize it. The concept of "factory" in the project's name expresses that a production process for software generation is to be sought which is comparable to the production of other industrial goods. Such a procedure presumes new work techniques and organizational concepts, new methods of software engineering and, above all, powerful software tools.

The necessary know-how can only be obtained in a European cooperation within the framework of EUREKA, by involving academic institutions, research establishments and industrial research divisions.

Deutsche Telekom's OPAL Optical Fiber Systems Described

93WS07254 Heidelberg NET—NACHRICHTEN ELEKTRONIK + TELEMATIK in German
Sep 93 pp 364-366

[Article under the rubric "Viewpoints": "Optical Fibers in Area of Subscriber Lines. Rosy Future for OPAL?"; first paragraph is an introduction]

[Text] Telekom is a world leader in the field of the use of optical fibers in subscriber lines. Just in June it awarded another major contract within the framework of the OPAL (Optische Anschlussleitung [optical fiber subscriber line]) projects: Over 500,000 residences are to be connected via optical fibers to the public communication network in 1994 alone. Have optical fibers in the area of subscriber lines already made the breakthrough with this?

Wolfgang Rosenau, Telekom's spokesperson for further system development in the communications network, reports on the current status of the OPAL projects, their importance for the new federal states, and questions of the economical use of optical fibers: "The opinion was come to in Telekom at the end of the eighties that the economical use of optical fiber technology in the subscriber line network could be reached within a few years with new engineering approaches. A series of a total of seven OPAL pilot projects was planned in order to test several especially promising design approaches. The projects aimed at having the first optical fiber series systems available as of 1994-95. With this various customer segments were to be provided cost-effectively with interactive services (telephone, ISDN, data transmission/communications) and the broadband distribution service.

With the reunification of Germany the opportunity arose to use optical fiber systems immediately in the new federal states—and, with that, considerably earlier than planned and substantially more extensively than originally hoped—in order to develop a telecommunications infrastructure with provision for expansion. The time schedule was made tighter and the system suppliers taking part were required to make an earlier start for this purpose. The systems were able to be put into service, their designs unchanged, in the period from 1990 to the beginning of 1992.

The OPAL projects were very successful, from today's viewpoint. The pilot systems supplied by various companies have passed their field tests well all down the line. The 'Passive Optical Network (PON) with a double-star topology (physical star/logical bus)' system version,

implemented almost uniformly and propagandized strongly by Telekom through contracts and publications, has meanwhile become the preference of leading network operators worldwide. This creates the possibility of the tremendous use of this system design henceforth. At the same time, with a dramatic drop in prices, it can be expected that Telekom will benefit with medium-term applications planning for OPAL systems.

However, at the present price level the economic efficiency cannot yet be proven down the line for any random case of application. To put it another way, the principle employed in OPAL systems of cost reduction (per connection) by apportionment of the investment cost to many users generally is not enough, even with a clever network design, to achieve cost parity with equivalent copper wire connections. Rather, areas of application have to be chosen for which the blanket use of an OPAL system will produce a saving as compared with an expansion, under consideration, of the copper wire network—in the area of the infrastructure for example (real estate, buildings, cable conduit dimensioning, etc.). Advantages that will compensate for or overcompensate for the still relatively high cost of the optical fiber transmission technology will result from this.

The handicap described will hinder, at least in the next two to three years, the appreciable use of OPAL systems in the old federal states, in which well developed copper wire networks only requiring rehabilitation at certain points exist.

The OPAL optical fiber systems show great potential (capacity, flexibility and provision for expansion). They are accordingly recommended—alone or in combination with SDH (Synchronous Digital Hierarchy) line equipment, as they are being tested in the VISION (Virtual Synchrones Ortsnetz [Virtual Synchronous Local Network]) projects—for a leading part in future subscriber line networks. In the longer term they will be able to contribute substantially to the spread of optical fiber equipment in the area of subscriber lines, up to the subscriber/customer (fiber to the home), as well as to the introduction of new transmission techniques (e.g., ATM, Asynchronous Transfer Mode).

At present Telekom is not aiming at any specific degree of optical fiber expansion for the subscriber line network. However, the new federal states rank especially high for the present. As announced in 1991, a total of 1.2 million dwelling units are to be connected via OPAL optical fiber systems and be provided with introduced services in the period from 1993 to 1995. The OPAL '93 program is currently in the implementation phase. The contracts for the OPAL '94 program were awarded on schedule to four system suppliers in July. The optical fiber expansion work will continue in the new federal states also in 1995 and thereafter, so that as many OPAL systems as possible can be installed as part of the continually necessary network expansion.

Differentiated Design Approaches

Optical fiber pilot systems for the area of subscriber lines have by now gone into service in numerous countries. How does this trend present itself from the viewpoint of an internationally operating telecommunications company? Questions concerning this to Norbert Hahn, press spokesperson and public relations head of Philips Network Systems, Nuremberg:

[NET] Mr. Hahn, Philips is participating nationally and internationally in various optical fiber projects in the area of subscriber lines. What are the goals of these projects, and which applications and services are being offered?

[Hahn] In 1991 Philips installed the PON pilot project with 200 terminals in Amsterdam. In Germany we have been taking part since 1991, for one thing, in OPAL 6 in Nuremberg-Boxdorf and in OPAL 93 within the FAST consortium (ANT, Kabel Rheydt [Rheydt Cable] and PKI [Philips]). In addition, Philips has implemented additional projects in Switzerland and in Germany, in which cable TV and radio programs are being provided or distributed via optical fibers.

The goal of these projects is, on the one hand, to prove the feasibility of new optical-fiber-technology network topologies and to demonstrate their economic efficiency, and, on the other, an increased demand for transmission capacity among subscribers is to be provided for. A separate differentiated design approach for each project has been the result. For instance, Philips has developed designs that work by means of one or several optical fibers, that work by means of wavelength division multiplexing, that permit flexible bandwidth assignment, etc.

Besides the engineering designs, the projects also vary as regards economic factors. For instance, there are to-the-curb (FTTC, Fiber-to-the-Curb) and to-the-home (FTTH, Fiber-to-the-Home) designs and a mixture of both. With regard to services, besides analog telephone lines, digital (ISDN) are being offered, as well as every broadband distribution service.

[NET] Are there differences as regards the approach in individual countries?

[Hahn] The projects differ not only with regard to the country, but also with respect to the existing environment. Telekom's OPAL projects, for example, had also the task of showing which approaches can be changed most economically for specific problems to be solved. The subscribers in Amsterdam are getting, along with digital telephone services, TV and radio programs transmitted in analog format.

[NET] Do private and business customers really require optical fibers in subscriber lines, then?

[Hahn] Broadband services like video conferencing or data transmission for CAD systems are required already today in several branches of business. The two-wire

copper lines laid till now can no longer transmit at these bit rates. Optical fiber lines present themselves as an alternative here. Because the demand for broadband services is growing in the private domain too, the transmission capacity necessary for them in the future can be implemented optimally by means of optical fiber subscriber lines. [NET] Therefore, the future belongs to optical fibers in local networks and in subscriber lines?

[Hahn] Yes. In the area of local networks the engineering systems for transmission that are required for this have already been developed. After pilot tests they will be installed as VISYON (Virtual Synchronous Local Network) optical loop networks in 34 cities in Germany. In the area of subscriber lines, Telekom alone has placed orders for over 200,000 stations in the new federal states for 1993. Because optical fibers are manufactured without copper, available deposits of which are limited, they in addition contribute, not least, to protection of the environment.

"The Requirements Are Growing"

How does a consulting firm assess optical fiber technology in subscriber lines in general and the OPAL projects in particular? Questions concerning this to Dr. Gurnad Sodhi, senior consultant at Eutelis Consult [Consulting] in Ratingen:

[NET] Dr. Sodhi, Telekom is playing a trailblazing role internationally with the OPAL projects in optical fiber technology in subscriber lines. Is this really the technology of the future?

[Sodhi] Yes, without question. Long-range cost-effective uses can be implemented by the joint utilization of services for voice, data and videophone transmission. That is, combined design approaches are at one's disposal—cable television and telephone or telephone and data transmission, for example. Transmission capacities can be assigned individually by means of flexible subscriber lines. The know-how gained in the OPAL projects is above all of strategic importance in addition. New buildings are being hooked up with FTTC (Fiber-to-the-Curb) technology, so that it will be possible in the future to provide subscribers optical-fiber conversational communication and distribution services.

[NET] Do private persons and business people require the optical fiber infrastructure in order to be able to use specific applications or services?

[Sodhi] Yes, over the long term. The multiple-use capabilities are addressed to both groups. The requirements of business and private customers are growing. The networks available today can hardly offer the data transmission speeds required in the year 2000. Fiber-to-the-Home will be employed by way of an optical fiber feeder line in order to provide television to out-of-the-way or nearly inaccessible local subscribers.

[NET] Is the blanket implementation of optical fiber subscriber lines (OPAL) with economic and technical efficiency possible?

[Sodhi] An optical fiber network has been implemented within the OPAL projects that can be operated efficiently with the services already available, like telephone and television or radio. The network structure was designed so that it will also be able to carry future services. Parallel call set-up with various transmission speeds is possible by means of new techniques like ATM, for example. In this way it is possible to adapt to the user's requirements better than with existing networks. There are cost advantages here versus copper wire networks.

[NET] Do you regard as wise the increased use of optical fiber technology in subscriber lines precisely in the new federal states?

[Sodhi] The telecommunications infrastructure in the new federal states has an enormous pent-up demand. Optical fiber local networks with about 40,000 subscriber stations are to be provided by the end of 1993 in Berlin, Cottbus, Gera, Halle, Leipzig, Magdeburg and Schwerin. The implementation of new technologies presents itself precisely because infrastructures are lacking here. The use of new systems can be tested in this way without regard for existing networks.

[NET] A major part of the orders for OPAL 94 went to the AT&T/Quante bidder team. In your opinion does this move indicate an opening or abandonment by Telekom of its "purveyors to the Court?"

[Sodhi] I think that Telekom in the future too will award its contracts not only to its "purveyors to the Court" but also to technology sponsors worldwide. In this way it will be able to utilize for itself new know-how and other ideas in the Fibre-to-the-Home area.

SGS-Thomson Develops Inexpensive Audio/Video Decoder Chip

93WS0719A Paris *ELECTRONIQUE LE MENSUEL DES INGENIEURS* in French Sep 93 pp 29-30

[Article by Francoise Grosvalet: "\$20 To Decompress Consumer Video"; first paragraph is *ELECTRONIQUE LE MENSUEL DES INGENIEURS* introduction]

[Text] SGS-Thomson is the first to come out with a cheap and complete two-circuit device for audio/video decomposition that is compatible with MPEG and H.261.

A really cheap solution for consumer video broadcasts: That is what SGS-Thomson is offering with its video decompression circuit that packs all the functions needed to process MPEG and H.261 standards on one chip. Indeed, circuit No. ST13400 is expected to sell in large quantities for about 20 dollars, or a price that exactly matches the needs of the consumer electronics industry it is targeting. Moreover, the Franco-Italian firm, which is developing its own circuit based on a digital signal processor, has just signed an agreement for

the audio portion with Sanyo. The deal allows SGS-Thomson to market a two-circuit device that is substantially cheaper than anything else on the market (about 30 dollars) starting immediately. And the agreement with Sanyo does not stop there; the two firms will also market sets of cheap circuits for interactive compact disc readers.

The First Decoder Compatible with MPEG 2

SGS-Thomson is also the first to introduce a decoder compatible with the future MPEG 2 standard, and thus adapted to cable or satellite digital-TV broadcasting. Moreover, the manufacturer is preparing, for sampling at the end of the year, a two-circuit set for real-time video compression as well. The set will be wholly compatible with the MPEG and H.261 standards, and will take the same economical approach.

The 3400 packs onto one chip all the functions of the 3240 (see June 1992 *ELECTRONIQUE LE MENSUEL DES INGENIEURS*), plus the inverse discrete cosine transformer (DCT) and additional features to facilitate its use. Two examples are a serial input port for compressed data and a vertical chrominance filter. Using 0.7 μm technology, the ST13400 packs about 300,000 transistors on a 80 mm² chip. The decoder will sell for about 20 dollars, a price that is expected to fall by half within the next two years. By switching to 0.5 μm CMOS technology like that the Crolles plant will soon use, engineers will be able to shrink the chip to 45 mm². This will allow them to fit audio and video decoders—that is, 500,000 transistors on an 80 mm² chip—on the same chip.

An Architecture Optimized for Low Consumption

The 3400's architecture is built around hardware operators, for as Guy Lauvergeon, the director of SGS-Thomson's image-processing section explains, "Total programmability certainly has the potential to be the most flexible solution, but it can be costly in terms of chip surface and consumption." "Conversely," he adds, "a total hardware solution, though very efficient in terms of chip surface and consumption, is rigid. So we took a blended approach, using hardware operators and enough programmability to accommodate a broad range of applications." The 3400's flexibility is supplied by a set of registers that allow the user to modify features such as display parameters. All the temporary storage required by the decompression algorithm—such as block line conversion buffer, image buffer, and bit buffer—are installed in an economical local memory that uses classic DRAM memories. The 3400 can address up to 32 Mbits directly, since memory control functions, including refresh, are incorporated into the chip. A minimal configuration employs four external DRAM Mbits and a microprocessor whose primary task is to initialize the decoder. Consequently, only one percent of the microprocessor's capacity is used.

The STi3400 consists of three main functional units, for compressed data, decoding, and display. The compressed data unit is composed of a compressed data interface that is included in the microprocessor interface, a bit buffer built into the local memory, and a bit-flow analyser to extract headers and decoding parameters.

The decoder is a pipeline that decodes at variable lengths and performs inverse DCT, inverse quantification, and block reconstruction operations. The display consists of a display memory installed in the local memory and a display controller driven by an external timing generator. The circuit also features a start code detector that enables the associated microprocessor to process the headers of upper layers of the MPEG standard (pictures, groups of pictures, sequence, and so on). The 3400 generates an output video signal in 4:2:2 or RVB format (using an integrated YUV/RVB converter) that is compatible with PAL (Programmable Array Logic) and NTSC formats.

Footnotes

1. The CCITT (International Telegraph and Telephone Consultative Committee) H.261 standard is optimized to transmit video information on low-speed channels, at the rate of p X 64 Kbits/s. It defines two picture formats: CIF at 352 X 288 pixels and QCIF, or 176 X 144 pixels. MPEG is optimized to provide better quality and higher speed (1 Mbit/s or more) for pictures of varying size.

More Efficient Microstrip Antennas Developed

94WS0012B Frankfurt am Main FRANKFURTER ZEITUNG: BLICK DURCH DIE WIRTSCHAFT in German No 180, 17 Sep 93 p 8

[Article by JB., Frankfurt]

[Text]

Microstrip Antennas Become More Efficient

Researchers in Aachen Are Developing a New Design Procedure

Conventional antennas are, for various reasons, not fit or desirable for aero-space flight or mobile radio communication. "Invisible" microstrip antennas provide a solution to the problem. They are paper-thin antennas consisting of discrete elements of centimeter-square size.

They are relatively easy to mount on the fuselage of a plane or on the roof of an automobile. They can be varnished, they occupy little space, and they do not perturb the vehicle aerodynamics. The Institute of High-Frequency Engineering at the Aachen University has recently developed a procedure which optimizes the geometry of microstrip antennas for higher efficiency.

These antennas consist of an electrical conductor structure on a dielectric carrier. They can be produced in large quantities by a simple photolithographic process. The individual antenna strips are only a few centimeters long. The functional design of such an antenna is, however, not always easy.

The configurations of these antennas are often intricate and necessarily based on prior design calculations. Calculations were till now the weak part of the design process, being too inaccurate and especially so when made by assuming a plane surface of the antenna carrier. In practice this is most often not the case. Along with other factors, the curvature of the antenna carrier also decisively influences the quality of reception. It can, moreover, give rise to interference effects.

Studies made by the Aachen researchers have revealed that the reception worsens with larger curvature of the antenna. Accordingly, it has become possible to develop a simple and fast design procedure which takes more accurately into account the antenna geometry and the coupling of the antenna elements. The procedure is said to be implementable on small computers and thus to be helpful in stimulating more widespread use of microstrip antennas.

Microstrip antennas make possible, among others, mobile reception of digital satellite-radio broadcasts and installation of the Global Positioning System. Microstrip antennas should also, according to the Aachen researchers, be suitable as hardly visible automobile antennas for radio reception.

Germany: Telecas ISDN System to Improve Wideband Transmissions

94WS0012D Frankfurt am Main FRANKFURTER ZEITUNG: BLICK DURCH DIE WIRTSCHAFT No 180, in German 13 Sep 93

[Article by JB., Frankfurt]

[Text]

Telecas Helps Sales in CIM-Aids Enterprises

Berlin Research Project for Future Wideband ISDN: Shorter Processing Times of Factory Orders

Telecas is an Integrated-Service Digital Network (ISDN) system assisting the salesperson of an enterprise. At the present this system is being developed by the Quantitative Methods Specialty Department of the Berlin Technical University (28-29 Franklin Street, Berlin 10 587). Telecas is to assist in sales problems, particularly enterprises which offer multiversant products to the capital goods industries. It is to be used not only for short-term deadline and price scheduling but also for product presentation and coordination of various operating units in the enterprise. The system is being developed jointly with the Federal Postal Service within a project which covers development and demonstration of possible applications for a future wideband ISDN.

Telecas is to supplement computer-integrated manufacturing (CIM) techniques and take care of overlaying specific customer problems. The usual components of the CIM concept include a production planning and control system which, among others, handles demand and capacity planning tasks, also plant construction, product planning, manufacturing, and computer-aided inventory control. Telecas now facilitates interactive access to data on all these aspects of enterprise operation.

Whenever a customer indicates an interest in making a purchase or just asks for information, the salesperson can, with the aid of Telecas through an ISDN, gain access to a central product catalog. Product presentation is made by the multimedia technique with pictures, graphs, audio segments, and video sequences, all electronically activated in the continuous mode. This enables the customer to look over the entire product platter and more precisely formulate special requirements which may come up.

After an order has been placed, it is formulated for production with the aid of a configurator. The configurator is a knowledge-based system integrated into Telecas for taking over the technically correct assembly of an intricate and multiversant product. This eliminates review of the order by the design department.

The configurator operates automatically in concert with the operational production planning and control system. The latter contains extensive financial-management and technical information. These include manufacturing cost and time data along with geometrical design data.

The cost is then calculated on the basis of these data and a deadline proposal is in real-time transmitted to the salesperson for presentation to the customer. All administrative decisions concerning the order can, in this way, be quickly arrived at and settled in a single meeting. The order is subsequently released to the factory.

Telecas using an ISDN network for data transmission can also be installed in geographically separate operating units so as to assist regional distributors in their work. Telecas will, so the Berlin researchers claim, result in a shorter order processing time from contact with the customer to delivery of the product.

Computer-aided production layout, say the Berlin researchers, will not only ease the problem of variants in conventional solutions but also diminish the design effort and help establish closer contact with customers. The entire product platter can, furthermore, be lucidly presented to the customer in place. Telecas requires a large computer capacity, however, especially for layout calculations.

Germany: Progress in Ultrafast Optical Signal Processing Achieved

MI2610105093 Bonn *TECHNOLOGIE-NACHRICHTEN*
MANAGEMENT-INFORMATIONEN
in German 20 Sep 1993 p 12

[Text] The "two-section distributed feedback (DFB)" laser developed by the Heinrich Hertz Institute (HHI) in Berlin constitutes a major milestone along the road toward ultrafast, purely optical signal processing in future telecommunications networks. It has brought a new, purely optical solution for clocking photonic components in a speed range never previously achieved.

Glass fiber cables, in which the signals are transmitted as flashes of light instead of electrical pulses, are increasingly being used in the place of conventional copper cables in modern telecommunications networks. The glass fiber networks in current operation reach a maximum speed of 2.5 Gbit/s (2.5 billion bit/s); this means that about 36,000 telephone conversations can be transmitted simultaneously over one glass fiber 0.1 mm thick. A future requirement for even higher speeds up to 100 Gbit/s (100 billion bit/s) is emerging, however. Firstly, speech data will increasingly be complemented with image data, and secondly, higher bit rates will exploit the almost unlimited transmission capacity of glass fibers to better effect, thus reducing transmission costs.

However, the transmission channels are not the only determining factor in the efficiency of a telecommunications network; units such as switching systems, regenerators, and terminal equipment, in which the signals are processed, amplified, stored, converted, and switched in the right direction, all play a significant role. The electronic systems currently used in these units are increasingly proving to be bottlenecks at the desired high clock pulse rates, as they can only match these high speeds with difficulty, and in any case at an increasingly high cost. Photonic components, in which photons perform the requisite functions instead of electrons, can, in principle, achieve higher speeds. Another advantage of using photonic components is that a purely optical network would obviate the need for the cumbersome and costly repetition of conversion from electronics to optics and vice versa.

However, the extent to which electronic components can be replaced with photonic equivalents has not yet been fully established.

The development work performed at the HHI revolves around a semiconductor chip the size of a grain of salt, what is known as a "two-section distributed feedback (DFB)" laser. It has been demonstrated that it can be used without any high-frequency electronics, basically running on two batteries, to generate cyclical light pulses with a repetition rate of, currently, up to 30 GHz. This is 1,000 times faster than the clock frequency in a conventional PC. The frequency can be adjusted over a wide range, for instance to a required data rate. A decisive

feature for application purposes is the fact that the periodic output signal can be locked onto the clock of an optically input data signal as regards frequency and phase, with the result that the data signal clock can be retrieved throughout the entire network. The optical signal thus generated can be used to clock a discriminator, i.e., for purely optical signal regeneration. Clock extraction has now been demonstrated experimentally at a data rate of 18 Gbit/s.

The light flashes emitted from the laser can also serve as the clock reference for the activation in time of other photonic chips that have to control and process the data flow with ultraprecise timing. The new functional element thus does a job similar to that of the piezoelectric crystal in electronics, which is used to regulate the timing of watches or computers with the utmost precision. This chip radically extends speed potential for signal processing in future optical networks.

Of course, the 18 Gbit/s achieved by the Heinrich Hertz Institute researchers is still a long way from their 100-Gbit/s goal, and it is by no means a foregone conclusion that they will actually achieve a substantial increase in speed, as not all the phenomena occurring in the laser have yet been understood well enough for definite predictions to be made. However, at all events the new functional element is a significant milestone on the road toward ultrafast, purely optical signal processing in future telecommunications networks.

It can also be integrated into the photonic circuits that are appearing on the horizon, and could develop into a major component for other areas, such as computer engineering.

Germany: Profile of German Telecommunications Industry

BR2610150693 Maidenhead TELEFACTS in English
Sep 93 pp 10-18

[Text] Since the official reunification of Germany in October 1990, the main priority for Deutsche Telekom has been to complete the process of technological integration with eastern Germany as quickly as possible. Plans to integrate the services of East and West Germany had been drawn up as far back as 1989, when the regime in East Germany began to crumble. The need to modernize the existing telecommunications infrastructure in the eastern laender is urgent. Not only must Deutsche Telekom create an efficient network infrastructure throughout the unified Germany, but it must be seen to be dynamic and financially strong in order to retain its position as a world leader in the telecommunications arena.

The PTT Today

Despite the general trend throughout Europe to privatize the national telecommunications operators, Deutsche Telekom is still a public corporation, owned by the Federal Republic of Germany. It is, therefore, bound by

the laws and regulations imposed by the constitution, as well as by federal laws. In June 1993, however, the Federal Government agreed to embark on the privatization of Deutsche Telekom. At the FINANCIAL TIMES Conference on Telecommunications in Central and Eastern Europe, held in Berlin in July 1993, the minister for posts and telecommunications, Mr. Wolfgang Botsch, said that the necessary legislation was to be introduced during the second half of 1993, and privatization would take place in several stages starting toward the end of 1995 or the beginning of 1996. He also indicated that he intended the proceeds from the sale of the operator to be used to ensure the modernization of the telecommunications network infrastructure.

Privatization is viewed as a positive move for Deutsche Telekom. In the past, it has been seen to be somewhat hampered by its lack of independence and most particularly in terms of being restricted in its foreign activities and decisions on investment of capital. During 1992, Deutsche Telekom's revenues totaled DM50 billion, representing a 6.4 percent increase on 1991 revenues—revenues of DM80 billion by the year 2000 are being targeted. The operator currently employs around 250,000 people (see Table 1).

Table 1. Deutsche Telekom: Financial Overview
(in DM thousands)

	1990 ¹	1991
Turnover	40,589,860	47,194,134
Staff costs	12,118,408	14,810,546
Capital and reserves	35,148,644	35,608,652
Fixed assets	108,817,797	121,194,070
Net investments	19,254,697	24,425,625
Depreciation	12,135,335	14,368,129
Profit/depreciation for the financial year	1,254,124	-124,158

1. Figures refer only to former West Germany Source: Deutsche Telekom

Voice Telephony currently accounts for around 90 percent of Deutsche Telekom's revenues. With the upsurge in mobile telephony and corporate data networks being used for voice communication, Deutsche Telekom estimates that this could reduce its revenues from voice telephony over the fixed network by around 5 percent by 1998—with Deutsche Telekom's revenues from voice telephony estimated at DM3.5 billion.

The business users and large customers sector will increase by 35 percent by 1995 (with the uptake of ISDN [integrated services digital network], mobile communications, and network management services), whilst the private user sector is predicted to grow by only 17 percent—as a result, by 1995, 55 percent of turnover will come from the business users' sector.

In order to meet the challenges of the competitive market and rapidly changing international telecommunications environments, Deutsche Telekom has made a number of organizational changes over the last couple of years. It has set three priority strategic objectives: to increase customer orientation; the decentralization of decisionmaking; and the improvement of Deutsche Telekom's efficiency.

As a result, in 1991, the sales and service organization was restructured to include independent sales and service units with the aim of better serving specific target groups such as residential and business customers. This has been followed by a further restructuring of Deutsche Telekom's corporate structure at the beginning of 1993 to increase the customer orientation. In January 1993, autonomous units were established, each being responsible for their respective professional activities.

Since the 1989 reform, Deutsche Telekom has made considerable changes in its strategy and has achieved an enviable position as the number one international carrier in the European market and number two worldwide.

From being essentially oriented toward the domestic market, Deutsche Telekom is now developing its international presence. Already, there are five foreign wholly owned subsidiaries in New York, London, Tokyo, Paris, and Brussels. Offices have also been opened in Moscow and Budapest during 1992. The operator's efforts have not gone unrewarded: Deutsche Telekom has made major inroads, in particular, into the newly opened markets of Central and Eastern Europe. It sees its position within the European and international arena as crucial and has become involved in a number of European projects and agreements, including the joint ventures with France Telecom, EUCOM (for value-added services), and EUNETCOM (for outsourcing and facilities management).

The Telephone Network

Deutsche Telekom still has a monopoly on telephone services, cable network infrastructure, and glass fiber optic network infrastructure. At the beginning of 1993, Deutsche Telekom had 34 million telephones connected to its telecommunications network, and between 60 percent and 65 percent of networks had been digitalized. Table 2 gives the latest available key network statistics.

Table 2. Deutsche Telekom: Key Services Statistics

	1987	1988	1989	1990	1991
Telephone services:					
Telephone connections (million) ¹	27	27.8	28.8	30	31.2
Telephone connections (millions) ²	1.7	1.8	1.8	1.9	2.4
Telephone calls (billions) ¹	30.3	30.4	31.7	33.9	38.9
Telephone calls (billions) ²	2.2	2.3	2.4	2.4	3
Voice mail boxes	200	200	400	1,100 ³	2,700 ³
ISDN:					
Basic ISDN accesses	-	-	1,400	7,600 ³	41,400 ³
Primary ISDN accesses	-	-	100	600 ³	2,600 ³
Data services (in thousands):					
Datex-P connections	26	35.3	45.2	56.5 ³	69
Datex-L connections	20	21.6	23.2	24.2 ³	24.7
Leased lines for data communications	164.4	184.7	204.6	231	-
Text services (in thousands):					
Telex connections	167.7	158.3	134.4	134.5	111.9
Telex calls (millions)	241.2	212.1	157.3	112.3 ³	84.3
Teletex connections	17.9	19.1	18.2	16.3 ³	14.1 ³
Teletex calls (millions)	21.4	22.8	19.9	15.2 ³	9.3 ³
Telefax connections	84.1	197.2	411.1	696.2	946.2
Videoconference service:					
Videoconference studios	79	102	158	275	410
Telekom videoconference studios	13	13	12	40	60
Private videoconference studios	66	89	146	235 ³	350 ³

Table 2. Deutsche Telekom: Key Services Statistics (Continued)

	1987	1988	1989	1990	1991
Mobile radio services (in thousands):					
Mobile telephone connections	74.2	123.1	185.5	292.6	546.6
Mobile telephones connected to the C network	48.7	98.8	163.6	273.9	532.3
Mobile telephone outgoing calls (millions)	26.9	27	150.8	192.4	251.9
Eurosignal connections	151.4	171.9	191.8	204.6	210.3
Cityruf subscribers	-	-	-	64.5	132
Cityruf transmission stations (Total)	-	-	-	319	575
Chekker mobile stations	-	-	-	2.7	11.3
Chekker base stations (Total)	-	-	-	24	55

[Caption] All figures indicated for the years before and including 1989 refer to the service area of the former West Germany. Unless otherwise stated, figures on existing facilities and traffic volume for 1990 and 1991 include the results for the five eastern laender.

Notes: 1) In the former West Germany only; 2) In the former East Germany only; 3) Results for the service area of the former East Germany not included.

Source: Deutsche Telekom

Table 3. Deutsche Telekom and Mannesmann Mobilfunk: Cellular Subscribers and Revenues

	1992	1993 ¹	1994 ¹
Subscribers:			
Deutsche Telekom ²	801,995	1,121,658	1,221,927
Mannesmann Mobilfunk	100,000	350,000	437,500
Revenues (DM billions):			
Deutsche Telekom	1.79	2.46	3.5
Mannesmann Mobilfunk	0.14	1.13	1.34

Notes: 1) estimated; 2) includes C1, B/B2, and D1 network subscribers.

Source: Northern Business Information/Datapro

B/B2 Network

Introduced in 1972, the B network was expanded in 1977, becoming the B2 network. Apart from Germany, coverage is also offered in Luxembourg, Austria, and the Netherlands. The B/B2 network reached its greatest number of subscribers in 1986 with 27,000 and this has now declined to around 10,000 (early 1993)—the network is to cease operation at the end of 1994.

C Network

Following trial operations in 1985, Telekom's analog cellular mobile radio system, C network was launched commercially in June 1986. The C network expanded rapidly with almost complete national coverage from the outset. Due to the increase in demand, the original capacity of 100,000 has been extended to around 800,00 at the beginning of 1993. According to Northern Business Information/Datapro estimates, Deutsche Telekom's C network subscribers totaled 795,618 in early 1993. Although digital networks are gaining new subscribers all the time, Telekom intends to keep the C network running beyond the year 2000.

D Networks

The two D networks are both digital mobile networks based on the GSM [Global System for Mobile Communications] standard using the 900-MHz frequency. D1 is operated by Deutsche Telekom, while D2, is operated by Mannesmann Mobilfunk, a subsidiary of the giant steel and industrial conglomerate Mannesmann AG. Having been granted its license in December 1989, Mannesmann began operations in July 1991. This marked an important stage in the drive to liberalization for German telecommunications. Deutsche Telekom's D1 network is scheduled to provide:

- Data service up to 2,400 bps circuit-switched (asynchronous) transmission by the end of 1993;
- Data service up to 9,600 bps circuit-switched (asynchronous/synchronous) transmission by the end of 1994;
- Packet-switched data transmission services up to 9,600 bps by the end of 1996.

Only nine months after Mannesmann's D2 network became operational, the operator was able to announce

in March 1993 a total of 200,000 subscribers. Roaming agreements had also been made with nine European countries and others were under discussion.

E1 Network

Following the award of Mannesmann's license, Germany has been looking to grant a third concession for a digital cellular mobile network. The E1 network is the newest addition to Germany's digital cellular mobile offerings and is similar to the Personal Communications Network (PCN). In February 1993, Mr. Wolfgang Botsch, the new Minister for Posts and Telecommunications announced that the multinational consortium, E-Plus, had been awarded a license to operate one of the world's largest digital cellular networks. The consortium comprises: the German industrial groups Thyssen (28 percent) and Veba (28 percent), BellSouth of the United States (21 percent), and Vodafone of the UK (16 percent). The remaining seven percent is accounted for by several German enterprises in the new Federal States and the French banking group Caisse des Depots et Consignation.

Like the D networks, E1 is also GSM-based; however, it uses the less crowded 1,800-MHz frequency and is therefore similar to the Personal Communications Network (PCN). It is estimated that by the end of 1995, the system will cover 88 percent of Germany and will have the capacity to support up to 3 million subscribers by the end of the decade. According to the FINANCIAL TIMES, an initial investment of DM 4.8 billion is required from the consortium and a further DM3 billion from suppliers.

Telepoint

In October 1990, telepoint field trials were commenced in Munster using CT1+ [cordless telephone] (CEPT+ [European Conference of Postal and Telecommunications Offices]). CT1+ was chosen as the technology, since at that time Deutsche Telekom was experiencing delays in receiving CT2/CAI equipment from Siemens/GPT for its telepoint network.

At the end of the 12-month trial, CT1+ was ruled out as too few suppliers were prepared to supply equipment.

Italy: Italtel Telephone Exchanges Installed in Arctic Circle

MI2210152393 Milan SISTEMI DI
TELECOMUNICAZIONI in Italian Sep 93 p 58

[Text] UT Line telephone exchanges, designed and manufactured by Italtel (part of the IRI-STET [Institute for the Reconstruction of Industry - Turin Telephone Finance Company] group) to operate at temperatures of below minus 50 degrees [Centigrade] will be installed in the Salechard telecommunications network. Salechard is a Siberian town located on the edge of the Arctic Circle.

Built in special containers that are suitable for any form of transportation, the new UT exchanges utilize special

technologies to withstand the difficult environmental conditions in which they will be working. Special aluminum alloy materials that are particularly resistant to low temperatures have been used, together with an airconditioning system that has no electromechanical parts, is completely maintenance-free, and has low energy consumption. The structure of the container has been designed using advanced computing techniques with CAD (computer-aided design) systems, so that there are no polluting electromagnetic discharges to the outside.

The UT Line exchanges, with a total of 10.5 million lines operating in 18 countries, are currently being widely diffused throughout the Russian telecommunications network. In fact, in only 18 months since the installation of the first UT exchange at Vyborg (St. Petersburg), Italtel has acquired important contracts for the supply of 500,000 UT lines in the Siberian regions of Jakutia, Tuminskaia, Kubas, and Hanti-Mansijsk. The first exchanges are already operating in the towns of Kagalym, Nizhnevartovsk, and Tjumen.

Spain: Nation-wide Coverage of Basic ISDN Anticipated by 1995

BR1410101393 Maidenhead TELEFACTS in English
Sep 93 p 1

[Article by Peter Ellis: "Spain Launches Commercial ISDN Service"]

[Text] As of 1 July 1993, Telefonica announced the start of a commercial basic rate ISDN [integrated services digital network] service called Red Digital Servicios Integrados (RDSI) based on the NET 3 standard. During 1993, basic rate ISDN facilities are projected in most principal business areas in Spain, including Madrid, Barcelona, Valencia, Zaragoza, Alicante, Asturias, Cadiz, Castellon, Malaga, Las Palmas, and Santa Cruz de Tenerife. In 1994, ISDN coverage will extend to other secondary regional centers. National coverage of 25 percent is predicted by the end of 1993, with full national coverage by 1995. Primary rate services are to be launched in 1994.

International ISDN connections currently exist with the United States (AT&T), the UK, Japan, France, Germany, the Netherlands, Belgium, Denmark, Sweden, Finland, Australia, and Singapore. Currently some 8,756 basic rate and 200 trial primary rate connections are provided. Telefonica expects to provide some 48,544 basic access connections and 3,096 primary access connections by 1995. Telefonica has been trialing RDSI since October 1989 and also runs a pre-ISDN system for metropolitan area use, Servicios Integral de Comunicaciones de Empresas (SICE), based on PCM [pulse code modulation] transmission along coaxial cable.

United Kingdom: State Invests 8.4 Million Pounds in High-Speed Networks

BR1410101693 Maidenhead TELEFACTS in English
Sep 93 p 5

[Article by Peter Ellis: "UK Government Announces 8.4 Million Pounds for High-Speed Networks Research"]

[Text] UK Trade and Technology Minister Patrick McLoughlin has announced an 8.4-million-pounds program to help industry benefit from the next generation of high-performance data networks. To be run jointly by the UK's Department of Trade and Industry and the Science and Engineering Research Council, it will aim to transfer knowledge about new network technologies from academia to wealth-creating industry. The remit for the High Performance Interfaces and Protocols (HPIP) program will be determined by a pre-project consultative phase when applications will be invited for projects to be supported by the scheme. In particular, the program will address the connection between advanced networks operating at over 140 Mbps and multi-media personal computers. Issues to be investigated include the robustness, speed, and quality of service provided by such interfaces as well as the dynamic allocation of bandwidth. Results from the program will be input to international standards forums.

Belgium: Prototype Broadband Network Operational

BR0710133993 Zellik TECHNIVISIE
(TECHNOPOLIS supplement) in Dutch
Sep 93 pp TP5-TP6

[Unattributed article: "Telecom (R)evolution: Belgacom and Belgian Broadband Association Demonstrate Broadband ISDN"]

[Excerpts] In 1988, Belgacom—which was still called RTT at the time—launched a unique research and demonstration project aimed at constructing a prototype broadband network based on the ATM [asynchronous transfer mode] standard. In this context, an appeal was made to a number of major telecommunications companies, such as Alcatel Bell, Alcatel Bell-SDT, Atea-Siemens, and Philips, which banded together to form the BBA (Belgian Broadband Association). On 27 May 1993, nearly six years later, a working broadband prototype has been demonstrated. This prototype called for investments totalling 2.3 billion Belgian francs (BFR), 80 percent of which was provided by Belgacom. The project cost its participants approximately 500 man-years.

Broadband Integrated Services Digital Network

Broadband ISDN [Integrated Services Digital Network] should make it possible to transmit speech or CD-quality music, high- or low-speed computer links, video conferences, or high-definition television [HDTV], etc. over a single switched (fiber-optic) network (i.e., a network which functions from the user's point of view like a modern telephone network). What makes the Belgian

broadband experiment unique compared with similar projects being conducted abroad is that, in addition to transmitting digital information handled by the telephone service (i.e., speech, video conferencing, and video telephones), the network can also handle image data obtained from TV stations and from an automatic video library. The prototype gives Belgacom and its industrial partners the basic knowledge they require to collaborate on international standards. Alcatel Bell applied itself primarily to the central switching exchange and control system; Atea-Siemens covered the video conferencing and corporate switchboards, and Philips concentrated on developing the prototype's audio, TV, and video processing capabilities. Alcatel Bell-SDT took charge of transmission and came up with a universal, variable bit-rate codec [coder/decoder]. Thanks to their contribution to this prototype, all the partners, including Belgacom, are now primed to collaborate on the European ATM project which is aimed at starting up a real ATM network by the middle of 1994. The project will involve the collaboration of the EC member states' 12 national telephone companies.

ATM Technology

The Belgacom prototype is based on the ATM standard (accepted as the CCITT [Consultative Committee of International Telephone and Telegraph] standard since June 1990). ATM stands for asynchronous transfer mode, a technology on which Belgium has done pioneering work.

Swift Market Penetration?

Narrowband ISDN has now been available for several years, and its number of users is now approaching its critical mass, which should offer this type of network a chance to penetrate the market. Major companies in particular already use ISDN networks. The system is out of reach of most users, since the rates are higher than those applying to conventional telephone services, and also because most (smaller) companies are not yet ready to explore the specific possibilities offered by ISDN (high-speed computer or fax communications, video conferencing, etc.). Consequently, one might well ask whether broadband ISDN is not merely an R&D product developed to show just what technology can do, rather than representing a response to an existing need.

However, narrowband ISDN has shown major companies the advantages of video telephones over expensive business trips.

In addition, users have also discovered its limitations. One of these is the fact that transmissions of documents and images (especially large volumes of data, such as reports, CAD [computer-aided design] files, moving video images, etc.) are too slow, which makes it better to send them via conventional channels (by mail) or simply by making use of (expensive) leased lines. Thus, it is expected that these users will welcome broadband ISDN with open arms, provided that such services are offered

at a competitive price. As major computer manufacturers are already producing equipment that can communicate using the ATM protocol—since they have accepted a single standard for high-speed computer networks—broadband ISDN services are expected to start up faster and penetrate the market faster than narrow band ISDN. "Service suppliers" who are seeking to use the future ISDN network can already obtain the necessary equipment, and even do so at affordable prices. For narrowband ISDN, this equipment had to be developed specifically for the ISDN telephone network, and the required price reduction is only now coming about (e.g., an ISDN card for a PC was recently unavailable under BFr10,000). However, the introduction of broadband ISDN requires the installation of an entirely new fiber-optic network. As soon as this has been done, it will probably be possible to offer this new telecommunications technology rather quickly at competitive prices. At the same time, new data compression techniques mean that existing twisted pair telephone infrastructure can even be used for a number of broadband ISDN applications (the current network is available at data transmission speeds of up to 2 Mbit/sec, which is sufficient for the transmission of moving images of acceptable quality).

Broadband ISDN is opening up new possibilities for real "services" aimed at residential users. This new technology will actually make it possible to work at home, hooked up to a company network. And once there is a connection into the home, other applications, such as "renting and watching video films," "purchasing products presented with the help of (moving) images from home," etc., will also be feasible "down the telephone line," without leaving home. However, it is unrealistic to imagine that broadband ISDN will quickly gain access to private homes merely by offering a range of services to residential users who do not require ISDN for professional purposes. Nevertheless, a swift market penetration is expected for business applications.

German-Russian Digital Mobile Phone Joint Venture Set Up

BR0311114293 Chichester INTERNATIONAL
TELECOMMUNICATIONS INTELLIGENCE
in English 4 Oct 93 p 3

[Unattributed article: "Russia - Deutsche Telekom/Siemens GSM Joint Venture"]

[Text] At the end of last month, Deutsche Bundespost Telekom announced a new joint-venture company that will further expand its entry into the Russian telecommunications market. DBT announced the creation of Mobile TeleSystems (MTS), a joint-venture company with Siemens AG, the Moscow State Telephone Company and other Russian partners. DBT's activities in the joint venture will be managed by its new mobile subsidiary, DeTeMobil. DBT told ITI that the two German partners, Siemens and DeTeMobil, jointly-own 47 percent of MTS.

The new company will build and operate a digital cellular telephone network in the Greater Moscow area which should be operational by the middle of 1994. DBT said that, together, Telekom and Siemens would finance DM160 million [German marks] of the DM330 million expected total cost.

In January 1993, the Russian Ministry of Communications selected consortia to provide 900MHz GSM networks in 12 regions across Russia. US West International has a role building and operating the systems in 11 of the 12 regions. The twelfth region was Moscow and this area was divided into Moscow City and Moscow Oblast. The selected operator in Moscow City was M-Bell, a consortium including Bell Canada and Moscow City Telephone Company. The consortium selected to provide services in Moscow Oblast was named Krakor and was thought to contain only Russian local telephone companies. DBT told ITI that its network will be built and operated within Moscow city itself. The current position of Bell Canada with respect to its involvement in GSM in Moscow city could not be ascertained at press time. DBT was not prepared to give details on how it had suddenly become involved in the project in Moscow city, describing the negotiations as "internal" and indicating that the company was still in pre-negotiation with MGTS.

Current projects in Russia in which DBT is involved include:

- The "Projekt 50x50" which, in cooperation with the long-distance operator Intertelekom, will result in the installation of a digital overlay network connecting 50 states and using 50,000 kilometers of optical fibre cable by the time it is completed early next century;
- InfoTel AO, a joint venture, in which all four partners own 25 percent, with the Moscow State Telephone Company, the Russian International Centres for Informatics and Electronics Inter EWM and the International Centre for Information Technology, which will build a nationwide digital packet-switched data network by the end of 1993;
- Teleport Ivanov, a project to build a Russian teleport to interconnect with international telecommunications networks via satellite, involving the DBT subsidiary Deutsche Fernkabelgesellschaft (DFKG) and Intertelekom; and,
- Russtel, a joint-venture company in Russia which holds a license for satellite communications in Russia. Russtel is owned by Russian partners and International Business Communications Systems, a US company in which DFKG has purchased a 25 percent shareholding.

Elsewhere in the other states of the former Soviet Union, DBT is already involved in projects in the Ukraine and Kazakhstan and has an agreement to become involved in a project in Belarus. DBT is also involved in the construction of the Trans-Europe-Line (TEL) project which

will create a fibre-optic backbone between Poland, Hungary, the Czech Republic and Slovakia and the Romantis satellite project being developed with ANT (Bosch) and Deutsche Aerospace in Russia, Ukraine and Kazakhstan.

UK Awards Telecommunications Contract to Mercury

*BR1410121993 LONDON HERMES DATABASE
in English 6 Oct 93*

[UK press release from the Office of Public Service and Science: "Government Telecoms Contract Awarded"]

[Text] The contract for providing the Government's long distance telecommunications network (GTN-LD) has been awarded to Mercury Communications Limited. This was announced by David Davis, Parliamentary Secretary, Office of Public Service and Science today. The contract let by CCTA, the Government Centre for Information Systems, is for five years starting on 1 April 1994.

This follows the decision to proceed with outsourcing the GTN-LD in line with the Government's policy of achieving value for money. The contract follows a competitive tender run under the EC Services Procurement Directive Negotiated Procedure.

The current revenue from the GTN-LD is around 13.5 million pounds per annum. The new contract could enable savings of up to 30 per cent for some government departments and executive agencies depending upon their size and use of the service.

Notes to Editors

1. The GTN is operated by CCTA, the Government Centre for Information Systems, on behalf of a wide range of government departments. It provides telecommunications services (predominantly voice telephony) to 250,000 public servants in about 550 government offices spread throughout the United Kingdom.

2. The long distance service (LD) of the GTN will be operated by Mercury under contract to CCTA and user government departments. The GTN London Metropolitan service will continue to be operated by CCTA.

3. CCTA, the Government Centre for Information Systems, is part of the Office of Public Service and Science. It is responsible for promoting business efficiency and effectiveness in the development and use of information systems, by government departments and executive agencies.

Brazil: Space Program Receives \$85 Million in Funding

94SM0023Y Sao Paulo GAZETA MERCANTIL
in Portuguese 16 Sep 93 p 12

[Article by Luiza Pastor: "Brazilian Space Program Receives \$85 Million From Privatization"]

[Text] Brasilia—Minister of Science and Technology Jose Israel Vargas announced yesterday that President Itamar Franco had guaranteed the Chinese-Brazilian program for developing earth satellites and the All-Brazilian Space Mission (MECB) \$85 million in funding from the privatization program.

Announcement of the funding coincided with the signing by Israel Vargas and the minister-president of the Chinese National Space Agency, Liu Jiyuan, of a protocol covering the main points agreed on by the two governments for developing the two earth resource satellites called for in the Chinese-Brazilian program. It was also yesterday that Israel Vargas obtained the release, through the DIARIO OFICIAL DA UNIAO, of \$7.6 billion for payment of this year's first installment on the joint program.

The fact is that the news served to relieve tensions between the Brazilian and Chinese Governments. Over the past two years, the Chinese Government has even considered canceling the agreement signed in 1988 by then President Jose Sarney, its reason being Brazil's apparent lack of interest as reflected in complete failure to carry out the program. Of the total cost of \$150 million, Brazil is responsible for \$50 million, but only \$7 million of that amount was made available between 1989 and 1992.

Thanks to confirmation of the appropriation of \$21 million for this year and of another \$15 million for the period from 1994 to 1996, Minister Israel Vargas was even able yesterday to persuade the Chinese Government to agree to one of the Brazilian space industry's most important demands in the program: that the second satellite called for under the cooperation agreement be assembled and tested in Brazilian territory—at the laboratory operated by the National Institute of Space Research (INPE).

After being tested on the ground, the satellite will be taken back to China, from where it will be placed in orbit by the Long March rocket built by China's Great Wall Company—which has already carried out 33 satellite launches and has 25 more scheduled over the next few years. The launch will take place at the base in Tai Yuan in Shanxi Province in the northern part of the country. Unlike the first satellite, which is scheduled for launching in October 1996, the second one does not yet have a definite timetable.

All-Brazilian Space Mission

At the same time that he confirmed the availability of funds for financing the Chinese-Brazilian program,

Israel Vargas announced that \$64 million for the All-Brazilian Space Mission (MECB) would come from the proceeds of the privatization program. Of that total, \$39 million will be allocated to the project for building the Satellite Launch Vehicle (VLS) and the launch platform at the Alcantara Base in Maranhao. This was an extraordinary appropriation, especially when one considers that the national budget had earmarked only \$12 million for the MECB this year.

"We are providing all the money requested of us by the Aerospace Technical Center (CTA)," said Israel Vargas. He also pointed out that another \$25 million had been set aside for building the supersonic tunnel as requested not only by the CTA but also by the entire aerospace industry.

According to the minister, the sudden flood of funds into the traditionally slim coffers of the Brazilian space program was due to "the government's political will not to invent new ways of doing things but instead to carry out projects which have already started and which are important in terms of science and technology." In announcing the new funding, he also used the opportunity to call upon the congressmen attending the event to speed up consideration of the government's bill creating a Brazilian civilian space agency. A date for voting on the bill is being held up pending an agreement among party leaders.

Brazil: Satellite Launch Program With PRC Reactivated

94SM0023Z Sao Paulo GAZETA MERCANTIL
in Portuguese 15 Sep 93 p 10

[Article by Luiza Pastor: "Brazil and China Reactivate Cooperation Agreement for Satellite Launches"]

[Text] Brasilia—Minister of Science and Technology Jose Israel Vargas and the minister-president of China's National Space Agency, Liu Jiyuan, will sign another agreement today in an attempt to reactivate the cooperation program between the two countries for launching two remote sensing satellites. The first talks on that agreement took place in 1988 during then President Jose Sarney's visit to China. The agreement called for launching the first satellite in 1994.

According to the timetable that will be announced today, it is expected that the first of the two satellites (SSR-1 and SSR-2) called for in the agreement will be placed in orbit by October 1996. The model will be developed jointly by the National Institute of Space Research (INPE) and the Chinese agency. Its budget had been set at about \$150 million, of which \$50 million was supposed to be Brazil's share of the project.

It was precisely the lack of that \$50 million which brought the program to a halt with little chance of its being reactivated—despite constant efforts on the part of the last three ministers of science and technology. The lack of budgeted funds ended up delaying Brazilian

participation, which was supposed to have been most intensive during the first phase of the program (involving manufacture of a number of components for the SSR-1). Assembly was to be the responsibility of the Chinese, and there was the possibility that some degree of participation by INPE technicians in that phase could be negotiated.

It was also hoped that Brazil would be assigned responsibility for some activity linked directly to ground tests of the second satellite (SSR-2) and its assembly as well as partial monitoring of the satellites during part of their orbits. And again, the negotiations were harmed by the Brazilian Government's apparent lack of interest in the program—as deduced by the Chinese from the lack of funding.

Surveys

The Chinese-Brazilian satellites are intended to survey earth resources. They will be lightweight satellites following an orbit lower than that used by communications satellites, and they will conduct surveys concerned with agricultural areas, forests, geology, hydrology, geography, cartography, and the environment. Since the satellites will scan a different strip of land than the ones currently being monitored by the Landsat (United States) and Spot (French) satellites, they will provide a Brazilian alternative to any possible embargoes on images such as the one that occurred during the recent Gulf War.

Iran: Profile of Telecommunications Industry

BR2710122593 Maidenhead TELEFACTS in English
Oct 93 pp 8-12

[Article by Doug Forbes-Jameson: "Iran: The Commercial and Regulatory Environment"; this report was written exclusively for Datapro International and appears in DATAPRO REPORTS ON INTERNATIONAL TELECOMMUNICATIONS.]

[Text] Iran is now the fastest growing telecommunications market in the Middle East, with an estimated growth rate of over 30 percent per year. The day-to-day running of the telecommunications network and the television transmission system is delegated to the Telecommunications Company of Iran (TCI), which has been given the onerous task of rebuilding and completely modernizing the network after the many years of neglect. By the end of this year (1993), TCI plans to have a direct line installed base exceeding 5 million, and if future targets are met Iran should be well on the way to having one of the most advanced telecommunications networks in the Middle East region.

The signing of peace with Iraq in 1988 began a new era for the enigmatic country of Iran. With its arch enemy, Iraq, preoccupied with its western adversaries, Iran had the whip hand in concluding a better deal with territorial concessions and the exchange of prisoners of war. The demise of Ayatollah Khomeini and the installation of

President Hashemi-Rafsanjani in 1989 also confirmed a much more moderate and pragmatic regime which aimed to improve its relations with the West and with Egypt and Saudi Arabia. Relative moderation has prevailed.

The post-Khomeini regime inherited a legacy of problems in a country that was in bad economic shape and was in desperate need of reconstruction and development. Despite criticism of the time it has taken to implement these programs and to restore Iran's shattered economy, Hashemi-Rafsanjani's government scored many successes, and by 1992 the gigantic reconstruction effort had started to pay dividends.

A major aspect of the reconstruction program has been the all-important oil industry (Iran is the world's number-four oil producer) which accounts for over 90 percent of total export earnings. The key to reconstruction is increasing the volume of oil exports and raising foreign loans, and here success has been evident. By October 1992, Iran's oil production had climbed to 3.8 million barrels/day—the highest level since the revolution of 1979—and by March 1993, the target of 4.5 million barrels/day had been met. According to the oil minister, Gholam Reza Aqazadeh-Kho'i, a sustainable 4.5 million barrels/day will be called for by the next five-year development plan. Following this period, the minister claims that this figure can be increased if the market justifies it and if it is consistent with government policy.

In the power sector, Iran, once the foremost nuclear power in the Middle East, is restarting its civil nuclear program with new deals with both Russia and China. The Russia-Iran deal includes the building of a nuclear power plant in Iran and the promise to work together in joint research, design, and construction of a power plant and the industrial production of components and materials. In the past ten years, Iran has concentrated on building up a pool of nuclear engineers and expertise. The discovery of uranium in Iran has added weight to the argument for continuing its nuclear program. Four large deposits of uranium have recently been discovered in the country.

While activities in the oil and power industries have been brisk, these have been more than matched by the rapid developments that have taken place in modernizing the country's telecommunications infrastructure. With the largest network in the Middle East, Iran has aspirations of transforming it into one of the most sophisticated in the region, on a level with Saudi Arabia and the Gulf States. The updating process is moving at a galvanizing pace, supported by a massive spending program running into billions of dollars—all part of Hashemi-Rafsanjani government's plan to establish Iran as the key commercial and industrial center of the Middle East.

The PTT Today

The day-to-day running of Iran's telecommunications network and the television transmission system is delegated to the Telecommunications Company of Iran (TCI) by the Iranian Ministry of Posts, Telegraphs, and Telephones. TCI divides its operational activities into three major areas: Long Haul, Local Area, and Toll and TV Transmission. Long Haul encompasses all aspects of long-distance transmission involving wireline and microwave radio services. Local Area and Toll embraces all types of switching equipment, CPE (PBXs, telephones, etc.) and all matters pertaining to the local loop and junction working.

The telecommunications network is also supported by the PTT's Tehran-based Iran Telecommunications Research Center which designs, develops, and manufactures a range of telecommunications products including switching systems, microcomputers, and waveguide components. Finally, there is a special TV branch which looks after all aspects of TV transmission throughout Iran.

TCI has been given the troublesome task of rebuilding and completely modernizing the network after the many years of neglect due to the war with Iraq and the revolution. The results achieved have been remarkable. With the introduction of the five-year development plan in 1989 backed by substantial investment, Iran is now the fastest growing telecommunications market in the Middle East with an estimated growth rate of over 30 percent per year. By the end of this year (1993), TCI plans to have a direct line installed base exceeding 5 million—double the capacity of the 1991 installed base. If future targets are met, it is possible that Iran could have 12 million lines by the end of 1996, and even assuming that the population continues to grow at the very high rate of 3.5 percent annually, this will increase the present telephone density of over 8 percent to 18 percent.

The government's anxiety to bring the country's telecommunications network up to date as quickly as possible is underpinned by the massive increase in investment that has taken place between 1989 and 1993. This has far exceeded the forecast in the original plan, and the result has been that TCI has been able to realize its objectives much sooner than was anticipated. For Iran's quarter of a million customers waiting for service, this is good news. While there is still an unsatisfied demand from the business community, there is also a pressing need to provide service for the country's rural and remote communities. Here, TCI is implementing plans to increase the use of TDMA [Time Division Multiple Access] radio equipment in an accelerated effort to provide service to 10,000 villages by the end of 1993.

The PTT assumes responsibility for the placing of all international tenders and bids for equipment and projects. Iran already has a number of established indigenous telecommunications equipment manufacturers

which include the Iranian Telecommunications Manufacturing Company, Iran Telecommunications Research Center, Rayon Electronic Company, VAFT, Iran Telecommunications Industries, and Karbord Electronic Company. However, the PTT is actively encouraging foreign companies to set up local production facilities and transfer technological expertise. Some of the big names have already set up their facilities. Siemens has transferred its technology and has a 20 percent stake in the Iranian Telecommunications Manufacturing Company which it co-founded. Siemens is supplying 1.2 million lines of its EWS digital switching system which should be completed by 1994. Alcatel, via its German subsidiary SEL [Standard Elektrik Lorenz], is also transferring its technology, and through Alcatel Telspace is supplying earth stations and VSATs [Very-Small-Aperture Terminal] for the domestic communications network. Alcatel CIT [Compagnie Industrielle des Telecommunications] has also installed Iran's first X.25 network. Japan, represented by NEC [Nippon Electric Company], has a 10-percent stake in Iran Telecommunications Industry (ITI) and was awarded a contract worth \$30 million to install a digital microwave radio backbone network. Scandinavia is represented by Ericsson, Sweden, and EB Nera, Norway, both of whom have received substantial contracts from the Iranian PTT.

Iran's first five-year plan is due to end this year (1993). The second five-year plan will be finalized in 1998, by which time it is estimated that the PTT will have invested more than \$6 billion in making the Iranian network one of the most modern in the Middle East region.

The Telephone Network

With the end of the first five-year plan (1989-1993), TCI is reportedly on course to have some 5 million direct exchange lines installed by the end of 1993. This is a considerable achievement when it is remembered that much of 1989 and 1990 was spent in restoring the main lines lost during the war with Iraq.

The vast investment in telecommunications equipment made by the Ministry of PTT has enabled TCI to bring forward many of its development programs. The public switching network, which was composed of an assortment of electromechanical systems, is being rapidly replaced by Siemens, Alcatel, and NEC digital switches. This is the fastest growing equipment sector where the three companies have joint ventures with local companies for the production of their switching systems. By 1995 it is expected that 75 percent of the Iranian switching network will be digital.

The payphone population has been growing at a compound annual growth rate of 9.6 percent since 1989. However, TCI means to step up the installation rate considerably and from the 1993 installed base of 21,500 it should rise to over 30,000 by 1995.

The Iranian transmission network is a mixture of microwave radio and coaxial cable links, but an increasing

proportion of long haul routes are being installed with fiber optic systems, which are gradually replacing coaxial transmission systems between the major centers. NEC, Alcatel, and EB Nera have been major contractors in providing the extensive digital microwave radio backbone network covering a large part of the country.

The second fastest growth area is the domestic satellite earth station network, which currently uses INTELSAT transponders on the Indian Ocean INTELSAT VI satellite at 63 degrees east, pending the launch of Iran's own domestic spacecraft. The domestic system provides communication and TV services for Iran's rural and remote communities. Over 60 earth stations for domestic communications have been supplied by Alcatel Telspace and 400 VSAT terminals are planned as part of the satellite network. Part of the PTT's future purchasing program includes the provision of 10,000 satellite earth stations. By June 1993, Iran was reported to have 85 INMARSAT-A mobile satellite terminals and 19 INMARSAT-C terminals in operation in land and marine applications.

In international communications, INTELSAT satellite services are the mainstay. Microwave links are also used to provide communications with neighboring countries and, with the installation of the 170-km unrepeaters fiber-optic submarine cable in September 1992, Iran is now linked with the United Arab Emirates (UAE). The installation was carried out by Alcatel Submarcon at a cost of \$5 million and links Jash, Iran, with Al Fujayrah, UAE, across the Persian Gulf. The 1550-nm system uses the latest unrepeaters fiber technology working at 140 Mbps.

Iran's international satellite network has now been extended to six Standard A earth stations:

- Isfahan 1, which accesses the INTELSAT VI satellite over the Indian Ocean at 63 degrees east.
- Shahid Dr Ghandi 3, which accesses the INTELSAT VA satellite over the Atlantic Ocean at 359 degrees east.
- Shahid Dr Ghandi 4, which accesses the INTELSAT VI satellite over the Atlantic Ocean at 335.5 degrees east.
- Shahid Dr Ghandi 5, which accesses the INTELSAT VI satellite over the Indian Ocean at 60 degrees east.
- Tehran 4, which accesses the INTELSAT VA (IBS) satellite over the Atlantic Ocean at 342 degrees east.
- Tehran 5, which accesses the INTELSAT VA (IBS) satellite over the Atlantic Ocean at 342 degrees east.

All the international earth stations are equipped with IDR (Intermediate Data Rate) capabilities.

Mobile Communications

TCI expects demand for cellular networks and terminals to emerge by 1994. Tehran, the capital city, with about 8 million people, will be the first to have the service. Other

major centers throughout the country including Isfahan, Mashhad, Tabriz, Shiraz, Ahwaz, and Abadan are likely to follow.

Data Communications

Alcatel CIT delivered Iran's first X.25 network at the end of 1992. During this year (1993), TCI anticipates that the national Iranian network will cover the entire territory with 24 Alcatel 1100 PSX nodes located in the country's major centers. The high-capacity network will offer 1,100 ports, enabling users to be connected in a choice of protocols including X.25, X.28, BSC, and SNA/SDLC, and capable of being used for frame relay.

One of the major problems in Iran has been producing software programs in Farsi. Following the revolution, foreign companies like IBM had to leave. IBM was a pioneer in the process of translating application programs to Farsi and with the company's departure, computer development virtually stopped. Despite some indigenous software producers coming up with a Farsi solution, none is compatible, and no standard has evolved. The compatibility gap has forced users to buy downloadable graphic cards such as EGA and VGA which enable them to work on any package regardless of the character set the program has been based on.

Text Services

The Iran telex subscriber base has been growing steadily since 1989 at a compound annual growth rate of over 12 percent, and by mid-1993 it was estimated to be about 9,500. TCI is currently modernizing the old electromechanical telex switching centers and offering improved facilities for domestic and international services. Demand is likely to continue until 1995 when it will tend to flatten as the facsimile base expands. Many government departments and commercial organizations have now adopted fax in preference to telex.

ISDN

Digitization of the switching and transmission networks is moving much faster than anyone could have predicted. Although TCI has given no definite date for the introduction of ISDN services, it seems likely that there will be at least a pilot service running in Tehran, and some of the country's major centers, by 1995.

The Future

TCI has exceeded all expectations in the implementation of its first five-year plan which is scheduled for completion this year (1993). The second five-year plan should see Iran well on the way to having not only the biggest, but one of the most advanced telecommunications networks in the Middle East region.

The post-Khomeini regime headed by President Hashemi-Rafsanjani has applied a pragmatic approach to putting the country back on its economic feet despite criticism from some quarters. TCI's continued progress in modernizing the infrastructure will, of course, be

directly related to the government's sustained investment. There is a strong determination to make Iran the leading commercial center in the Middle East once more. Oil production is back to the pre-revolution days, and the government is confident that this level can now be sustained.

The improved economic conditions in the country have brought a new air of optimism to Iranians who were suffering from a bad case of post-war depression. The Hashemi-Rafsanjani government has set its targets high in its endeavors to provide the country with a modern network. For TCI, and for the foreign telecommunications manufacturers who have participated in joint ventures, the future looks good.

India: High-Speed Data Link Facility Presented

93WS0037 Bangalore DECCAN HERALD in English
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[Article by G.S. Varadan]

[Text] Information Technology has made rapid strides over the last couple of years. It is projected that worldwide by 1995 \$500 billion will be spent on applying information technology. Of this, software is expected to have a lion's share of about 60 per cent contributing to nearly \$300 billion.

The United States is the leader with IT spending in 1990 amounting to 110 billion (30 per cent of the global spending on software). Japan's total spending on software was \$55 billion in 1990 constituting 18 per cent of global spending. Germany has the largest software market in Europe with a growth rate of 21 per cent. France's software spending is of the order of \$21 billion. The UK is the next marketing outlet in Europe with \$18 billion spent on software. Singapore's information technology industry was estimated at about \$1.5 billion in 1991 and is growing rapidly with 27 per cent of total revenue attributed to software spending.

In India the potential leverage for information technology is enormous. Information technology can compensate for scarce resources and rise productivity levels, making the Indian industry highly competitive on the world stage.

Export of software related services can fuel the engine of Indian IT development generating vital hard currency earnings and transferable expertise. Conversely an open and thriving IT on the market place can spur software/services exports.

As software development essentially means putting the brain power to extensive use, India has a great advantage. Availability of large number of intelligent, English speaking and trained manpower backed up by an excellent academic, R & D support gives India a great advantage to be a major global player.

The Department of Electronics, Government of India has taken the lead for India in promoting export of

software from India. The DoE has introduced various policies and fiscal measures to accelerate the growth of software exports.

Software exports have risen steadily over the last 4 to 5 years, from \$67 million in 1988-89 to \$225 million in 1992-93. The growth over the last two years in particular is very appreciable. Software exports showed a 57 per cent growth in rupee terms in 1992-93 over the year 1991-92. Even in dollar terms software exports have shown a 37 per cent growth which should be considered very high for an industry which is hardly a few years old.

The DoE, with the support from the World Bank developed the conceptual framework and instituted a study on potential and strategies for Indian software and services export. This study says that well-directed actions software export of \$1 billion can be achieved by the year 1996. The study has also recommended a number of coordinated efforts to achieve the target mentioned. The study highlighted India's competitive edge over few of the developed countries such as Ireland, Singapore, Israel, China and others.

While bringing out the comparison based on important criteria such as technical competence, ease of doing business, labour cost, telecom infrastructure, etc., it was understood that India can overtake its immediate competitor, namely Ireland, if the telecom infrastructure can be improved.

And to provide this the DoE and the Software Technology Parks of India stepped in. The Software Technology Park, Bangalore has emerged the leader in setting up infrastructure facilities including high-speed data communication facilities. The network facilities herein after referred to as SoftNET encompasses different services to meet the requirement of various sizes of software exporters.

A reliable and dependable communication system is a pre-requisite for undertaking any international business operation. State of the art telecommunication facility is the backbone of the information technology industry. An excellent data communication facility is essential not only for software development but also for other emerging areas like software maintenance, application re-engineering, remote computing and off-shore project execution business.

The DoE, under the Software Technology Parks (STP) scheme, has started SoftNET to cater to the data communication needs of software exporters to provide impetus to software exports.

The main objective of SoftNET is to provide a cost-effective solution for the 64Kbps digital line and usage priced dial-up value added services.

SoftNET aims to provide state of the art data communication facilities and value added network services by using its dedicated satellite Earth station and point to

multipoint radio equipment. The land lines are avoided in its plan in order to increase the overall reliability of its services.

The services under SoftNET are planned keeping in view the price-performance factor to cater to the needs of all sizes of software exporters depending on their affordability.

Under SoftNET the following services are available.

SoftPOINT is a point to point nx64 kbps digital private line service. This service connects software exporters in India to their clients abroad having full 64Kbps digital connectivity.

SoftLINK is a transmission control protocol/Internet protocol (TCP/IP) based value added network service which provides 24 hour access to the global commercial IP networks. This service is available over Ethernet LAN.

SoftPAC is an X.25 based packet switching network service which allows users to access other international public data networks. This makes use of direct access

facility of one of the public data networks in USA. It also provides access to different E-mail Systems.

Recently STP-B demonstrated the video conferencing capability between Bangalore and Rockville, USA. Such facilities could be made available to other parts of the USA, as well as other countries and presently discussions are on to make such services available. This would of course largely depend upon the commitment from the industry to use such facilities.

STP-B has generated expertise to offer consultancy in network planning for industries in order to get the best out of 64 Kbps digital private SoftPOINT services.

The experience gained in setting up SoftNET at STP-Bangalore has led STP-India to plan a similar facility for Hyderabad, Gandhinagar, Bhubaneswar. The facility at these places should be in position by the end of the year.

It should be possible to link the satellite earth station at Bangalore to other near-by places through the use of VSAT network. This could provide opportunity for employment generation for data capture business.

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